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ABSTRACT

This proceedings volume contains 77 papers. Subjects addressed include: image processing; new faculty research methods; preinstructional activities for preservice teacher education; computer "window" presentation styles; interface design; stress management instruction; cooperative learning; graphical user interfaces; student attitudes, interests, and motivation; effects of relevance on mental effort; hypertext computer-based instruction; image maps on the World Wide Web; virtual reality; computer simulation; instructional design; Internet-distributed college courses; instructional technology; case-based instruction; the social construction of knowledge; Gagne's theories; lifelong learning; use of music in multimedia design; electronic mail; hypermedia; history in educational technology; philosophy and educational research; student-centered learning; motivational screen design guidelines; multimedia software evaluation criteria; lesson structures; corporate education; hypertext in process writing instruction; teletraining; telecommunications for teacher professional development; technology resource teachers; cultural diversity; retention and depth-of-processing; feedback; art images and visual literacy on the World Wide Web; constructivist design; color in instructional multimedia; cooperative software; educational television; learning styles; and distance education. ERIC document (ED) numbers of previous proceedings, Research and Theory Division officers, and paper reviewers are listed, and a sample AECT membership application is provided. (AEF)

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SELECTED RESEARCH AND DEVELOPMENT PRESENTATIONS

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PREFACE

For the eighteenth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is sponsoring the publications of these Proceedings. Papers published in this volume were presented at the national AECT Convention in Indianapolis, IN. A limited quantity of this volume were printed and sold. It is also available on microfiche through the Educational Resources Information Clearinghouse (ERIC) system.

REFEREEING PROCESS: All research papers selected for presentation at the AECT convention and included in this Proceedings were subjected to a rigorous blind reviewing process. All references to author were removed from proposals before they were submitted to referees for review. Approximately fifty percent of the manuscripts submitted for consideration were selected for presentation at the Convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

A selected number of development pages, sponsored by the Division for Instructional Development (DID), are included in this Proceedings. The most important instructional development papers were selected by the DID program chairs for publication.

This volume contains two indexes. The first is an author index; the second is a descriptor index. The index for volumes 1-6 (1979-84) is included in the 1986 Proceedings, and the index for volumes 7-10 is in the 1988 Proceedings. After 1988, each volume contains indexes for that year only.

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What is AECT?

AECT is the only national, professional association dedicated to the improvement of instruction through the effective use of media and technology. AECT assists its members in using technology in their jobs and to enhance the learning process.

Who belongs to AECT?

☐ Media specialists
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☐ Librarians
☐ Instructional designers
☐ Corporate/military trainers
☐ Learning resource specialists
☐ Curriculum developers
☐ Television producers and directors
☐ Communications specialists
☐ Education administrators
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☐ Hypermedia
☐ Interactive Video
☐ CD-ROM
☐ CDI
☐ Teleconferencing
☐ Film and Video Utilization
☐ Telecommunications
☐ Computer software and hardware
☐ Projection/presentation products
☐ Intelligent tutoring systems
☐ Videodiscs
☐ Distance learning
☐ And more!

AECT's publications, convention, trade show, and conferences present the leading edge on research and practical applications for these and other technologies.

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Unlike some other special-interest technology organizations, AECT has a long history with over 70 years in educational technology. We've grown up with technology, advocating its integration into education from films to integration into education from films to overheads to interactive video and hypermedia.

AECT began as the Department of Visual Instruction at the National Education Association in 1923, in the days when visual aids consisted of films and slides. In 1947, as educators were adapting technology used to train World War II service personnel for the classroom, the name of the organization became the Department of Visual Instruction (DAVI). Twelve years later, DAVI became an affiliate of the NEA and finally the autonomous association, AECT, in 1974.

Today, AECT keeps an eye on the future of instructional technology while assisting educators with the changes and challenges that face them now. AECT members, now numbering 4,500, are professionals devoted to quality education. They care about doing their jobs better and want to embrace new methods, new equipment, and new techniques that assist learning.

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Research and Theory Division (RTD) improves the design, execution, utilization, evaluation, and dissemination of educational technology research and theory; advises educators on using research results.

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Appendix F: Other papers presented at the 1996 AECT Conference...............................F-1

Title:

The Effects of Congruency Between Structural & Contextual Dominance in Image Processing

Author:

Bob Appelman

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The problem with pictures is that they are largely contextually defined instead of being structurally defined. That is, it is much more common for a person to describe a picture in terms of the contextual objects (people, places, or things) within the picture than in terms of the visual elements that make-up the picture (circles, squares, points, lines, colors and shading). One might say, "Of course! It would be too cumbersome to describe a picture in those terms because they are not specific enough!". This statement is true if you are only considering the contextual meaning of a picture. Circles, lines, and points, have no contextual meaning of an by themselves. However, if an artist wishes to create or modify a picture, the only elements available for this purpose are lines, circles, squares, color and shading. There are no art brushes that paint faces automatically such that when the brush is dragged across the canvas a face appears. Instead the artist must vary lines, shapes and points, combined with shading and textures, in such a way as to produce contextually recognizable elements in the picture. The question is then, how does and artist know how to vary these structural elements in such a way as to produce the desired contextual meaning of a picture if these elements have no contextual meaning of and by themselves? Even more problematic is how an instructional designer specifies a necessary picture to an artist such that the appropriate contextual meaning is communicated from the picture the artist creates.

In an instructional message there are often subtle, yet critical, aspects that must also be emphasized in supportive graphics or images. The instructional designer must be able to describe the contextual emphasis such that an artist or graphic designer will be able to manipulate the structural elements of the picture in a corresponding fashion. The goal is to make the structural emphasis congruent with the contextual emphasis. The emphasis of the contextual message and the emphasis of the structure of a picture is referred to in this paper as contextual dominance and structural dominance respectively.

In an instructional message the contextual dominance is most often conveyed in the form of printed or spoken sentences. Within any sentence used in conjunction with a picture are nouns or phrases that directly relate to contextual elements within the picture. For instance if we are presented a picture and heard "The man walked through the door." we would expect to identify a man and a door in the picture. Both "man" and "door" may be called referents in the sentence since they refer to objects perceptible in the picture. The study described herein varied the dominance of referents used in a number of sentences and compared the patterns of subsequent observations of 15 pictures. The goal was to identify structural and/or contextual elements that stimulated consistent patterns of observation. A brief discussion of the literature, the methodology used, results for two pictures, and a summary of conclusions follows.

Synthesis of the Literature

Discussing how someone views and image depends also on describing the image itself. Most of the research to date use contextual definitions to describe the images and not structural ones; but, there have been some attempts to quantify the structure in terms of variations of color, complexity and layout.

Color, Complexity, and Layout

In general color has been found to be helpful when utilized to emphasize dominant contextual features, but it is a distracter when not relevant to context (Luder & Barber, 1984; Yarbus, 1967; Reid & Miller, 1980) For instance, Luder and Barber found that color could be utilized to highlight specific elements within a complex display, while Reid and Miller found that full color illustrations of anatomical drawings presented too many distracters from what was considered important in the drawing.

Complexity and picture layout has been found to elicit different viewing strategies among students. Specifically, Malcolm Fleming utilized four "layouts", one with a caption preceding an illustration and another with it following. Each of these layouts also varied by complexity. Utilizing eye movement as a dependent variable, he found that gender and previous experience with the information were strong factors as to which strategy to process the information was chosen-- image first or caption first (Fleming, 1984).

Another attribute, which relates to complexity, is that of the "degree of realism" to which an image may be attributed. The "degree" represents a continuum from concrete, or realistic, to abstract, or non-realistic. Gavriel Salomon describes this continuum operationally in terms of the degree of "coding" one must do when encountering a visual representation of something.

> *"Certain representations appear to be more "realistic" because their symbolic form comes closer to the way users represent the depicted entity to themselves. The less recoding something requires, the mentally "easier" it is to experience and the more "real" it appears." (Salomon, 1981 pg. 201)*

Relative to this "concrete to abstract continuum", concrete images are remembered better than abstract images (Paivio, 1983; Winn, 1982; Findahl & Hoijer, 1976; Wolf, 1970). On the other hand, abstract graphics have been found to be more successful in educational contexts due to fewer structural elements (Heuvelman, 1987).

Visual Design of an Image

One aspect left largely unstudied in most of the research in image utilization is that of the visual design of the stimuli being used. Visual design here refers to the structural relationships of visual elements within an image. Layout, mentioned earlier in the Fleming study of complexity, is the closest variable this researcher found in the literature to that of visual design. Nesbit captured this very common problem in the following statement.

> *"Little attempt was made to examine the design qualities of the picture itself or the component cues of the picture in terms of learning theory. All modes of pictorial representation were considered as infinitely large masses of stimuli and examined as such... no attention was given to isolating those elements which make an instructionally effective visual." (Nesbit, 1978 pg. 496)*

The variable of style was of interest to Molner. He believed that traditional definitions of style, usually treated as purely affective and subjective, were identifiable in terms of structural attributes of an image. His eye movement study of Renaissance and Baroque paintings illustrates that the structural attributes of paintings may be utilized in such a stylistic manner that it can influence the viewer to scan an image at a certain speed and focus. He found that art of the Renaissance was viewed with large and slow eye movements, while Baroque art produced denser and shorter eye movements (Molner, 1981).

Image and Language Processing in a Context

Utilizing a "dual-coding information processing" model of learning, Kozma points out that if information in long-term memory may be stored, not only semantically but pictorially as well, then images can be retrieved into short-term memory in response to either nonverbal or verbal stimuli. He summarizes the research by stating that if the same information is stored both pictorially and verbally, it is more likely to be retrieved (Kozma, 1986).

Just as printed text under an image provides contextual information utilized to view an image, so does spoken text during or immediately preceding an image affect the processing of that image. Many media today entail the learner processing audible textual information and visual information arriving at the same time. Very few studies have examined the intricate interactions involving the chunking, sequencing, and pacing of these dual-channel stimuli. But, it has been confirmed that the majority of the contextual effect is provided by the verbal text, and when verbal contextual cues are presented prior to viewing an image, a semantic attention to the image is evoked (Koroscik, Desmond, & Brandon, 1985).

This strategic focus supports previous prescriptive conclusions relating to color, complexity, and the schematic design of an image. Both point to contextual cues dictating structural prescriptions in the visual channel and specific reliance on the verbal channel for being the major carrier of contextual information.

Koroscik, Desmond, and Brandon examined this relationship among structural, semantic, and verbal contextual information. They began the study with the following hypotheses: It was speculated that the encoding and retention of art is subject to the type of contextual information given to viewers at presentation. Verbal labels with literal references to the objects, persons, or events depicted in an artwork ought to evoke semantic encodings that differ from those generated in response to verbal references pertaining to the work's expressive qualities and/or other non-literal aspects of the depicted content. (Koroscik, 1984 pg. 332)

By presenting first a verbal contextual cue and then presenting an image, they were able to measure the effect of the context on retention of the desired message. Since the contextual cues referred literally to structural elements within the images, some information was also gained about the degree of distraction of "non-pertinent" structural elements. Results also indicated that accurate interpretation of meaning was a function of the level of abstraction that characterized each artwork and of the type of contextual information given at input (Koroscik, 1984).

These results offer very few prescriptions to a message designer other than a sense that context and the structure of an image may somehow be interdependent. On one hand structural concerns are important for immediate interpretation and long-term memory, yet on the other there is, at some point, a shift of focus to contextual aspects of an image. Which is dominant, structure or context? What is the relationship between the abstract-to-concrete word continuum and an abstract-to-concrete image continuum? The concept of congruency begins to explore the relationships posed by these questions.

Congruency Between Images and Language

In his review of the contributions of eye movement studies to research, Marschalek states:

> *..thus the compositional structure affects perception most dramatically when structure and meaning are united within the same areas of the picture. (Marschalek, 1986 pg. 135)*

This succinct statement encapsulates the idea of congruency between words and images. The concept of congruency between the structural components of an image and the context presented is of extreme importance to the message designer. Congruency deals with the basic problem of linking words and images together. Many researchers have found that when structural features and contextual features are congruent, then attention to the message is maximized (Heuvelman, 1987; Hsia, 1977; Marschalek, 1986; Miller, 1982; Nodine, 1982; Wember, 1976)
A growing number of cognitive scientists are specifically looking at the relationship between the cognitive processing of words and the processing of images. A Dual-Coding Theory was developed by Paivio which stated that:

> *"The verbalization of a picture's features increases the probability that two codes are activated in the formation of stimulus memories. The argument is that sensory features of pictures are stored in imagery codes, while the products of verbalization are retained as verbal or linguistic codes." (Madigan, 1982, pg. 80)*

This statement is contrary to a "common code" view that says pictures somehow possess a faster access than words to a common conceptual system. The dual-coding view, on the other hand, sees picture-word latency differences as stemming from a time consuming translation from one symbolic code to another and that semantic information required in the decision task is typically stored nonverbally. Numbers of other researchers have been testing similar concepts and have arrived at some meaningful conclusions. Segal and Fusella (1970) found, by using interference tests, that cognitive processing is modality (visual or audio) specific, i.e., the brain operates with a separate processing system for each modality. Nugent (1982) and Wickens (1984) found that "learners process pictorial and linguistic information through functionally independent, though interconnected, cognitive systems."

Whenever one deals with issues of context, they are subject to personal interpretation as to their meaning, importance, and dominance. For an individual, attribution of meaning will depend on knowledge the viewer already has, knowledge that can be associated with the incoming information (Heuvelman, 1987). This view is commonly held by many researchers and recent language comprehension studies have indicated that language processing involves a context-dependent knowledge base that operates in an integrative and elaborative manner (Anderson & Ortony, 1975; Barclay, 1973; Bransford, Barclay, & Franks, 1972; Marschark & Pavio, 1977). Dillen (1983), Braden & Walker (1980) and Wise (1982) also point to prior knowledge of the individual as a variable which significantly determines how an image will be perceived. Craik and Lockhart place prior experience as a comparative referent within the memory storage system. These researchers go on to describe two stages of the memory formation process. They are:

EARLY STAGES...	the analysis of physical features of incoming information...and
LATER STAGES...	concerned with matching input against stored knowledge from past learning, and with abstracting meaning."

Some researchers have consistently found that when images are utilized which include people, fixations center on their faces to the almost total exclusion of anything else in the image (Buswell, 1935; Chu & Schramm, 1975; Guba, et al, 1964; Yarbus, 1967). The implication of this is that people know from experience that faces and animate objects, in general, are primary providers of contextual information.

Animate objects receive a higher density of fixations than inanimate objects when both are contained in the same picture. When considering portraits, the highest density of fixations occurs on the eyes, nose, and mouth because these areas of the face tend to convey information concerning emotion and the degree of physical attractiveness of the individual. (Yarbus, 1967 pg. 28)

Structural and Contextual Dominance

A primary concept within this study, in relation to the analysis of contextual and image structure, is that of dominance. It has been found that it is possible to define an image in terms of its physical structure apart from its contextual elements (Friedman & Polson, 1989; Koroscik, 1984; Marschalek, 1986). Likewise it is proposed that linguistic analysis can focus on both the structural aspects of a sentence apart from the contextual aspects (Mason, Kniseley, & Kendall, 1979; Smith & van Kleeck, 1986). In each of these four categories it is proposed that a dominance exists which may be utilized in comparing these categories, resulting in a description of congruence, non-congruence, or ambiguity. It is toward the definition of image structure, and specifically those structural elements which affect dominance, that this study is directed.

Since no models emerge from the literature, we may turn to the discipline of graphic design for a description of visual form by Wucius Wong (Wong, 1972, pg. 6) which seems to fit a hierarchical description of visual form. An adaptation of his hierarchy appears below.

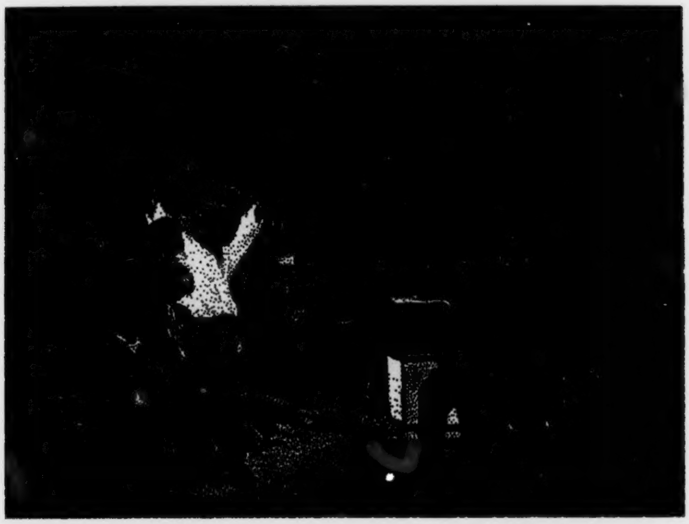
Visual Form:

as BASIC ELEMENTS	*of Point, Line, Plane, Volume*
as STRUCTURAL ELEMENTS	*of Shape, Size, Color, Texture*
as RELATIONAL ELEMENTS	*of Contrast, Direction, Position, Space, Gravity*
as CONTEXTUAL ELEMENTS	*of Representation, Function, Meaning*

These 4 levels of visual form give us not only a language to describe what we see in an image, but also a hierarchy which is harmonious with our previously stated levels of analysis. Describing visual form in this manner is no simple task, for in order to compare images reliably they must be described in terms of their attributes at each of these four levels. It is not long before one realizes that in fact it indeed takes a thousand words to describe a picture. This overwhelming task of image description is reduced through the use of the concept of dominance.

In discussing the structural form of an image, the most appropriate discipline to draw from is art criticism or art history. Specialists in this field are skilled in using words to describe images. A common practice of many art historians is to reduce what may seem to be a very complex image to a few general shapes, colors and textures. An example of this is a description of Goya's "The 3rd of May 1808: The Execution of the Defenders of Madrid" (Fig. 1)

Figure 1



Its organic structure, based on triangles and strong diagonals, is peculiarly fitting to the theme, and its neutral colors in grays and browns, with a splash of red in the pool of blood heightens its emotional impact." (Gardner, 1959, pg. 443)

One item to note from this description is the implication that these structural elements are arranged to produce an emotional impact and not a linguistic one. This underscores the dual-coding caveat of images being processed in the affective domain of cognition. This description is very brief and encapsulates hundreds of individual elements into gross generalizations. It is necessary to exclude lesser elements if we must focus on the dominant ones. It is interesting to note that even this brief description alludes to contextual elements of the "theme" and the "pool of blood" and is obviously formed as a caption intended to be read while viewing the painting. This underscores the difficulty in separating contextual elements from structural ones.

There are hundreds of individual structural elements including at least 22 people, 16 faces, all of their wearing apparel, weapons, the foreground elements, the city in the background and the dark night sky. That we can attribute meaning to the shapes and brush strokes alerts us to the fact that we are using contextual descriptions of structural elements. If we use entirely contextual descriptions Goya's painting becomes much simpler. We could describe it as an image consisting of three groups of people in front of a wall with a city in the background. Another description of the same work is presented to illustrate almost an entirely contextual description.

> *"Here the blazing color, broad fluid brush work, and dramatic nocturnal light are more emphatically Neo-Baroque than ever. The picture has all the emotional intensity of religious art, but these martyrs are dying for Liberty, not the kingdom of Heaven; and their executioners are not the agents of Satan but of political tyranny -- a formation of faceless automatons, impervious to their victims' despair and defiance. " (Janson, 1965, pg. 479)*

It would seem to this researcher that Goya would support both this description and Gardner's earlier one because he chose structural elements and manipulated them in such a way that the later contextual description would be perceived. He chose to manipulate the structural elements of grays and browns so that the red pool of blood would be dominant. The two overlapping triangular shapes point like arrows toward the two dominant groups of people. We view the scene just an instant before the pure, bright white shirt of the rebel is to become crimson from the lines of the rifles pointing directly at it. In both examples stated above, the structural features of the image are tied directly to the contextual features. The artists have selected and arranged structural elements in such a masterful way that the desired context is effectively communicated to the observer. Another way to state this is that there is congruence between the structural dominance of the image and the contextual dominance that was the intent to communicate.

Based on the findings in the literature and translated into the terms of dominance, context, and congruency, the following hypothesis were adopted for this study and which the methodology was designed to test.

H_1. Congruency between structurally dominant elements and contextually dominant elements will result in greater attention to these elements than in less-congruent situations.

H_2. As the complexity of an image increases, the structural dominance will decrease.

H_3. As structural dominance decreases, attention will be directed more to contextual elements.

Methodology

Subjects

A total of 21 subjects were used in this study drawn from a graduate class in research design at Indiana University. 13 subjects across two experimental groups received events with the same sequence of images, the verbal context being the only difference between groups. 8 subjects made-up a third control group exposed to images only.

Definition of Variables

The Contextual Dominance Variable

he verbal contextual dominance variable was defined as a spoken phrase immediately preceding exposure to an image. For each stimulus event, contextual dominance was derived from the nouns within each phrase and then given points that were interpreted in terms of the image. Due to the need to compare the verbal contextual variable to the image structural variable, the contextual dominance was described in terms of the referents appearing in the image sectors.

The Image Structural Dominance Variable

The image was described in terms of two criteria, structural dominance and degree of complexity. The first level of image description, or structural dominance, was defined in terms of prioritized sectors of the image as assigned by a panel of visual design experts.

The Image Complexity Variable

The second level of analysis was that of complexity. Complexity was determined simply be tabulating the number of structural elements visible in the image, e.g. 10 lines, 20 circles, 6 shapes, etc. In this study images were grouped into simple, medium, and complex categories. The criteria for inclusion in the simple category was having less than 10 structural elements, in the medium category by having more than 10, but less than 50 elements, and in the complex category by having over 50 structural elements in the image.

The Congruency Variable

Identifying the degree of congruency between two groups was a statistical process of shared dominance comparisons. Based on the Experts' rankings of structural dominance, phrases were constructed which either referred to this dominance or referred to less dominant sectors of the image. Congruency was defined as an independent variable with two conditions. A "Congruent Condition" existed when the contextual phrase that was heard referred to elements identified as part of the image structural dominance. The phrase which referred to less dominant elements within the image was assigned to the non-congruent condition.

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Materials

Fifteen images were divided into three groups of five according to the above complexity criteria. Structural dominance was determined and validated by a panel of visual design experts. Two contextual phrases were written for each image with one phrase written to match the structural dominance of the image and the second phrase focusing on weaker structural elements of the image.

A sample from each of the three levels of complexity follow:

Simple Complexity

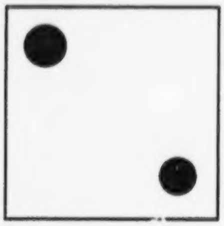

Fig 2 (Image #5)

Image Structure description

Shapes:	2 circular shapes (1/5 width diameter)
Colors:	black and blue on white background
Textures:	solid (no textures)
Relational:	diagonally positioned with the blue circle in the upper/left ninth of the frame and the black circle in the lower/right ninth of the frame.

Contextual Phrases

Congruent:	Since blue knights are instinctively afraid of black dragons, he ran.
Non-Congruent:	Since black knights are instinctively afraid of blue dragons, he ran.

Moderate Complexity

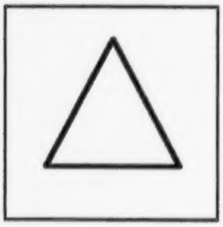

Fig 3 (Image #8)

Image Structure description

Shapes:	1 hollow triangle shape made of moderately thick lines.
Colors:	black on white background
Textures:	solid (no textures)
Relational:	Isosceles triangle fills over 1/3 of frame and is centered in frame.

Contextual Phrases

Congruent: A pyramid points to the sky.
Non-Congruent: A pyramid is heaviest at its base.

Complex Complexity

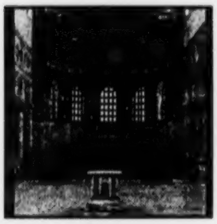

Fig 4 (image #14)

Image Structure description

Shapes: lines and a variety of shapes but mostly rectangles, 1/4 sphere, circle sections.
Colors: grayish beige, bluish green, white, yellow.
Textures: rough (stone-like), and slick
Relational: symmetrical 3-dimensional space, white object at bottom, illustration at top of image.

Contextual Phrases

Congruent: The center alters were usually simple with only two candles and a cross.
Non-Congruent: The biblical phrase "The Lord is my shepherd" is reflected in the decorations around the half dome.

Procedure

Gathering Eye-Movement Data

Fig 5

Subjects were asked to sit in a specialized "head-stabilization" chair (Fig. 5) A small light was place adjacent to their right eye and a video camera was trained and focused on the eye ball and a portion of the light. The strategy was to record the reflection of the light on the cornea of the subject relative to the stationary light bulb. Following a registration process, the stimulus materials were presented.

Recording Eye-Movement Data

The videotape was subsequently played-back one frame at a time and the motion of the reflection of the light off of the subject's cornea was documented s being in one of nine sectors of the frame.

Statistical Analysis

The Within-Group analysis-

Groups A, B, C, and the Expert Group were included in the analysis for each of the 15 images. All data were converted to percentages so as to allow for a direct comparison between the stimulus events and the Expert rankings. A Kendall Coefficient of Concordance (W) was computed for each group associated with each image. This resulted in a rank-ordering of the means of fixations for each sector of the image, a Chi-Square, and a significance value for each group. If the result of the Kendall test was significant, then a more rigorous test of significance, the Friedman Two-Way Analysis of Variance by Ranks, was calculated. If significance was acceptable, calculated by the Friedman test, then a multiple comparison between individual rank-order means was calculated to determine the significance of a sector's dominance (Siegal, 1988).

Analysis of Eye-Movement Data

The raw data, which consisted of an ASCII file of 75 data pairs, 1,C 2,C 3,B 4,E ... 75,H , were read into a HyperCard Stack and sorted into the total number of fixations registered in each of the nine sectors.

Determining Dominance from Rank-Order Comparisons

Dominance for experimental data (that which was derived from eye movement data), as well as the ranking by the experts, is defined as those sectors which produced significance from the Comparison of the Means. These sectors are then said to represent 100% for the Dominance for that experimental group of data and are discussed in terms of the percentage which each sector claimed of that dominance. For instance, in the example below(Fig. 6), the dominance for the congruent condition of image 8 (Sectors B and E) is 89% and 11% respectively.

Figure 6

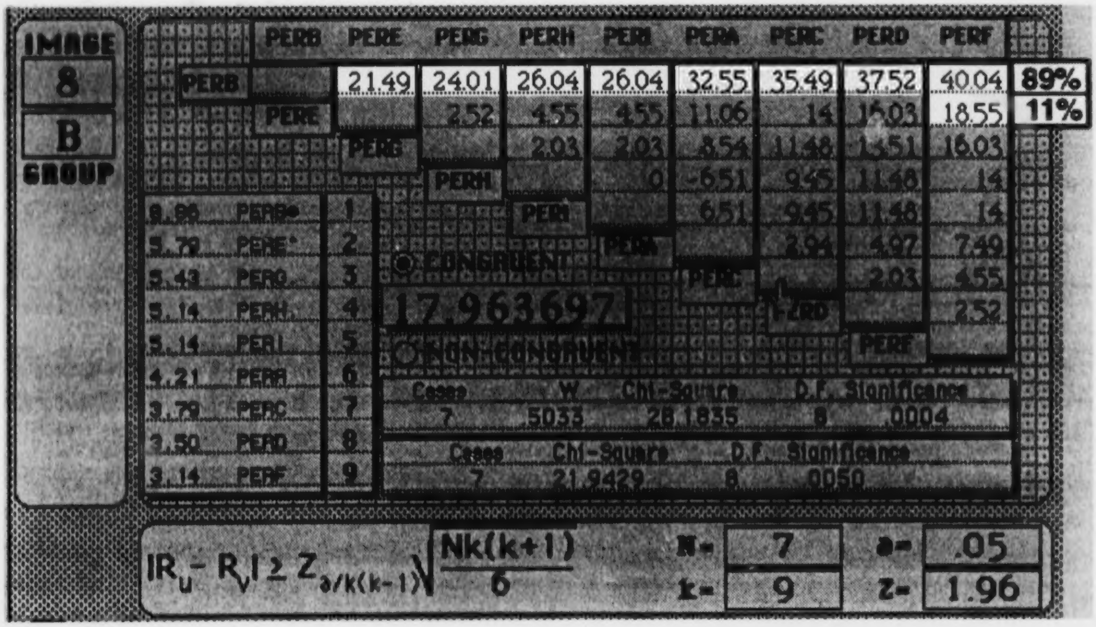

IMAGE 8

B GROUP

	PERB	PERE	PERG	PERH	PERI	PERA	PERC	PERD	PERF	
PERB		21.49	24.01	26.04	26.04	32.55	35.49	37.52	40.04	89%
PERE			2.52	4.55	4.55	11.06	14	16.03	18.55	11%
PERG				2.03	2.03	8.54	11.48	13.51	16.03	
PERH					0	-6.51	9.45	11.48	14	
PERI						6.51	9.45	11.48	14	
PERA							2.94	4.97	7.49	
PERC								2.03	4.55	
PERD									2.52	
PERF										

8.86	PERB*	1
5.79	PERE*	2
5.43	PERG	3
5.14	PERH	4
5.14	PERI	5
4.21	PERA	6
3.79	PERC	7
3.50	PERD	8
3.14	PERF	9

● CONGRUENT

17.963697

○ NON-CONGRUENT

Cases	W	Chi-Square	D.F.	Significance
7	.5033	28.1835	8	.0004

Cases	Chi-Square	D.F.	Significance
7	21.9429	8	.0050

$$|R_u - R_v| \geq Z_{a/k(k-1)}\sqrt{\frac{Nk(k+1)}{6}}$$

N= 7

k= 9

a= .05

Z= 1.96

Determining Contextual Dominance

Contextual dominance was determined by identifying the nouns within the contextual phrases and assigning points in relation to:

1. their position within the sentence,
2. the presence of visual modifiers that were also in the image, and
3. whether they were a focus of attention within the sentence.

The points accumulated for each noun were then assigned to the sectors of the image to which the noun referred. The sectors to which the nouns referred represented 100% of the contextual dominance and were represented in terms of the percentage which each sector claimed of the dominance.

The Between-Group Analysis

Congruency

A "Congruent Group" was defined experimentally as a group which received an audible contextual stimulus which contained a referent to a structurally dominant element within the image. The assignment of an experimental group to either the Congruent data group (CG-S) or the Non-Congruent data group (NCG-S) was based on a strategic decision by the experimenter to match the contextual referents heard verbally with the structurally dominant attributes within the image.

The Degree of Congruency (°CG) was a post-hoc statistic used to describe the relationship between data groups in terms of the overall similarity of their shared dominance. This statistic produced a number, from 0 to 100, with the most congruent condition being 100. This procedure was executed as follows (see Fig. 7):

Corresponding sectors within each of the two data groups being compared were sequentially added together producing a "Sector Sum". Also these same numbers were subtracted from each other to produce a "Sector Difference". The process was repeated for each sector as long as there were values present within the sectors being compared. The sector sums and

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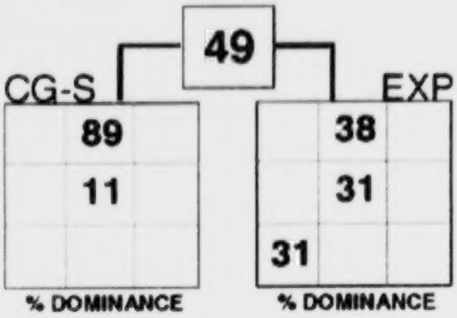
the sector differences were totaled, then the difference between these totals was found, and this figure was divided by 2 to produce the final result.

The formula for determining the Degree of Congruency (°CG) was as follows:

(Σ(sector sum) - Σ(sector difference)) ÷ 2 = °CG

Figure 7



For example, comparing the EXP group with the CG-S group in Figure 7:

38 +89=127 & 31+11=42
Σ(Sector Sum)=127+42=169

89-38=51 & 31-11=20
Σ(Sector Difference)=51+20=71

(169-71)÷2= 98÷2= 49 = °CG

Determination of Structural & Contextual Effects

In order to examine the effects of the structural dominance and contextual dominance on the Congruent and Non-Congruent data groups, the sector of primary dominance of each was compared. The percentage of the dominance accrued in the sector was considered to be representative of the contextual effect for that group. The same procedure was followed for the Non-Congruent data group.

A similar approach was utilized to determine the structural effect. The sector of primary dominance for the Expert data group determined which sector of the Congruent or Non-Congruent data group represented the structural effect for each group.

The Effects across Complexity

The images were grouped into 3 levels of complexity -- Simple (images 1-5), Moderately Complex (images 6-10), and Complex (images 11-15). By plotting the contextual effects for each image, an examination of the interaction effects of complexity was undertaken.

Results

Comparison of Groups by Image

Data Group Definition

Since treatments for congruency were randomized among experimental groups A & B, and later recoded into groups of congruency, groups A & B do not appear as units in the results section. Instead, each stimulus event (the presentation of an image, with or without a specific phrase) is identified as being either congruent or non-congruent. These events are coded as congruent or non-congruent depending on whether or not the contextual dominance of the verbal phrase matches the structural dominance as defined by the Experts. This recoding establishes 6 groups for comparison.

Experimentally defined:

(EXP)	Ranking-Structural Definition / Expert data group
(FR-S)	Eye Fixations / Free-Viewing data group
(CG-S)	Eye Fixations / Congruent data group
(NCG-S)	Eye Fixations / Non-Congruent data group

Theoretically defined:

(CG-X)	Contextual Definition / Congruent Condition
(NCG-X)	Contextual Definition / Non-Congruent Condition

Within Image Results

Presented here are the results of one image from each of two complexity groups. Individual within-group data are presented graphically via a nine-sector rectangle containing the resulting percentage of dominance indicated in the appropriate sector. The sector which is primarily dominant is outlined with a solid box. The Kendall W and the Friedman test results are presented adjacent to each data group's dominance rectangle. The Degree of Congruency is indicated in a box joined by two lines connecting the groups being compared.

After the presentation of the results of each of 2 images, will be a discussion of the results across the 15 images by complexity. This comparison will utilize only the Kendall W and the primary sector that relates to the structural and/or contextual dominance.

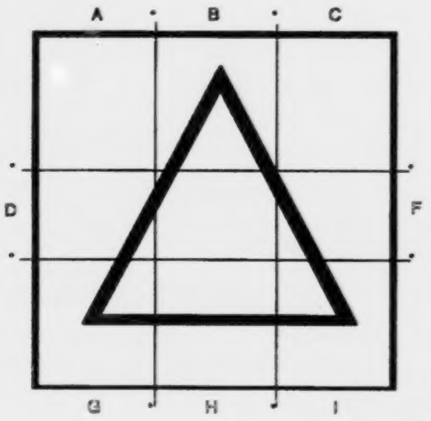


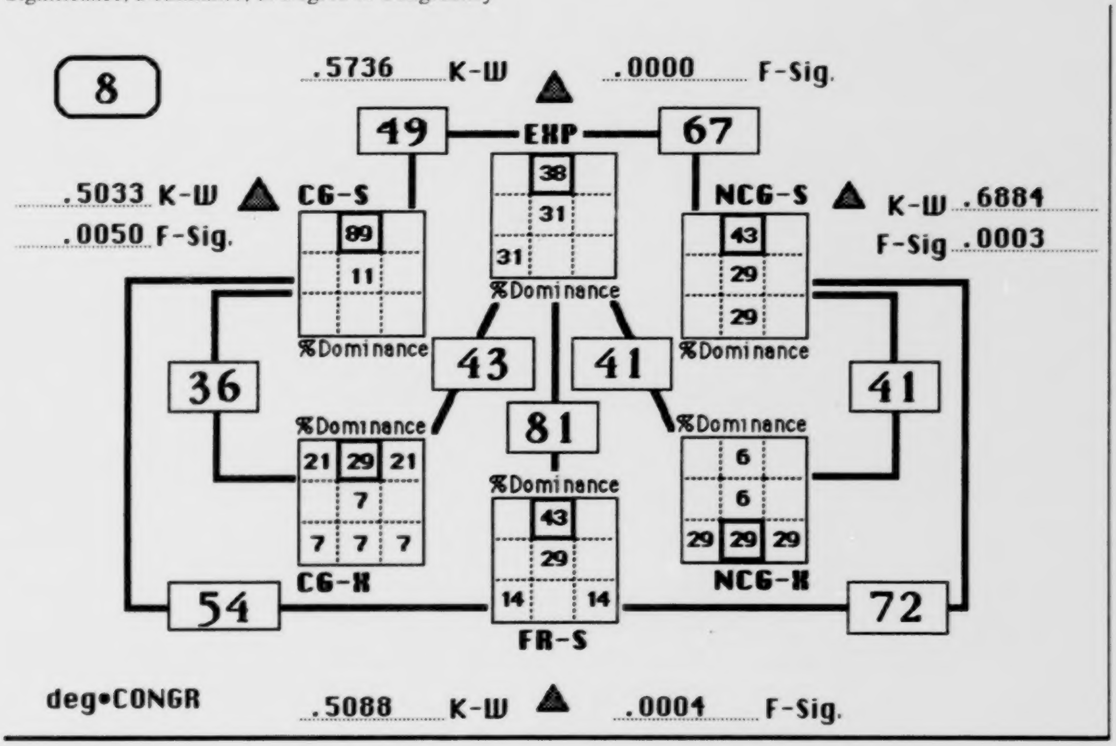
Image #8

Contextual Definition

Congruent		**Non-Congruent**	
A pyramid points to the sky.		*A pyramid is heaviest at its base.*	
[N]	[N][AN][LN]	[N]	[N][AN][LN]
1B,1E,1G,1H,1I	**3A,3B,3C**	**1B,1E,1G,1H,1I**	**3G,3H,3I**

Eye Movement Results

Kendall W. Friedman:
Significance, Dominance, & Degree of Congruency


8
.5736 K-W
.0000 F-Sig.
49
EXP
67
38
31
31
%Dominance
.5033 K-W
.0050 F-Sig.
CG-S
89
11
%Dominance
NCG-S
K-W .6884
F-Sig .0003
43
29
29
%Dominance
36
43
41
41
81
%Dominance
21 29 21
7
7 7 7
CG-X
%Dominance
43
29
14 14
FR-S
%Dominance
6
6
29 29 29
NCG-X
54
72
deg•CONGR
.5088 K-W
.0004 F-Sig.

Verbal Summary for Image #8

Strategies and Anticipated Results

From a visual convention standpoint, a triangle is one of the three basic graphic shapes (the others are a circle and a square). This shape also is utilized as the head of an arrow which implies direction toward the tip (which would emphasize sector B if structural dominance is strong). The triangle was rendered in outline form so as to highlight the space inside the shape as well (sector E). The contextual cues were designed to emphasize the top in the congruent condition and the bottom in the non-congruent condition in the anticipation that fixations would dominate these sectors if there was a strong contextual dominance effect.

General Stimulus Event Comparisons

Ranking of sector preference was significant beyond the .01 level for all data groups. Uniformity of image processing was moderate for the Expert data group, as well as for all experimental groups.
•$\mathbf{W}_{(EXP)}$ =.5736 & $\mathbf{W}_{(FR\text{-}S)(CG\text{-}S)(NCG\text{-}S)}$ of **<.6884**

Congruency Comparisons

The Degree of Congruency (°**CG**) between what the Experts identified as structural strengths in the image and how the Free-Viewing data group viewed the image was moderately strong. °$\mathbf{CG}_{(EXP|FR\text{-}S)}$ **=81**. The match between the Free-Viewing data group and the Congruent data group was moderate, $^{\circ}\mathbf{CG}_{(FR\text{-}S|CG\text{-}S)}$ **=54**, and the match with the Non-Congruent data group was moderately strong, $^{\circ}\mathbf{CG}_{(FR\text{-}S|NCG\text{-}S)}$ **=72**.

Structural & Contextual Dominance Comparisons

A very strong Congruency effect was evident in the Congruency data group with this image. Nearly 90% of all fixations were accumulated in sector **B** ($\mathbf{D}_{B(CG\text{-}S)}$ = **89%**). The Structural effect, in the Non-Congruent data group, was strong enough to draw enough attention from the contextually dominant sector H producing a strong attention to sector **B** also ($\mathbf{D}_{B(NCG\text{-}S)}$ = **43%**). There was some contextual effect evident in the Non-Congruent data group, evidenced by attention to sector **H** ($\mathbf{D}_{H(NCG\text{-}S)}$ = **29%**), compared to no significantly dominant fixations appearing in sector **H** for the Free-Viewing data group ($\mathbf{D}_{H(FR\text{-}S)}$ = **0%**).

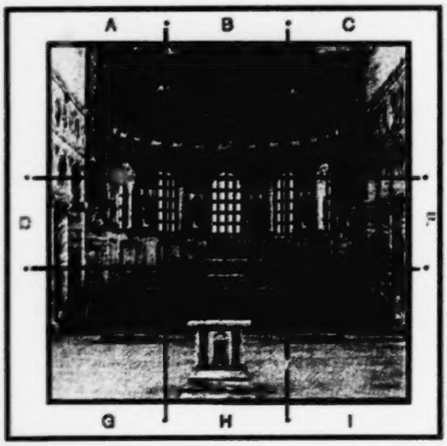


Image #14

Contextual Definition

Congruent

The center alters were usually simple with only two candles and a cross.

[N] [VN] [N] [N][LN]

2H **1H** **2H,2B**

Non-Congruent

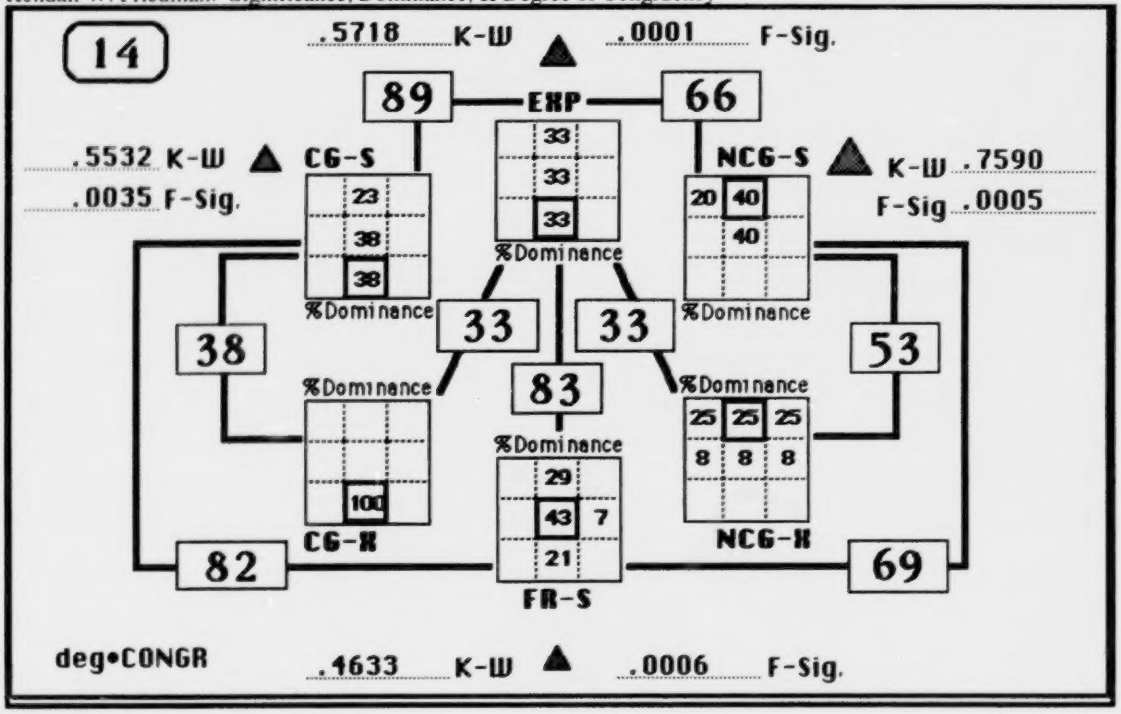
The Lord is my shepherd" is reflected in the decorations around the half dome.

[N] [N] [N] [N][LN]

1B **1A,1B,1C** **1A,1B,1C,1D,1E,1F** **2A,2B,2C**

Eye Movement Results

Kendall W. Friedman: Significance, Dominance, & Degree of Congruency



14
.5718 K-W ▲ .0001 F-Sig.
89
EXP
66
.5532 K-W ▲ CG-S
.0035 F-Sig.
NCG-S ▲ K-W .7590
F-Sig .0005
33
33
33
%Dominance
23
38
38
%Dominance
20
40
40
%Dominance
33
33
38
53
83
%Dominance
%Dominance
%Dominance
25 25 25
8 8 8
100
CG-H
29
43 7
21
FR-S
NCG-H
82
69
deg•CONGR
.4633 K-W ▲ .0006 F-Sig.

Verbal Summary for Image #14

Strategies and Anticipated Results

This image is the only "realistic" photograph of the 15 images. The picture was taken from the point-of-view of someone standing in the center of the room at an eye-level of the second alter. This angle accentuates the architectural perspective lines which converge just under the center window. These perspective lines alone were expected to draw strong fixations to sector E.

The first "object" encountered in this image is the "floor alter", which is referred to in the congruent condition's contextual cue. A focus on sector H would reinforce a congruent condition. The non-congruent contextual cue refers to the mosaic illustration above the center window, which is the largest graphic element in the image, as well as the largest architectural element (the half-dome in sectors A,B, & C). Due to the complexity of this image, it was anticipated that the contextual effects would be strong predictors of the eye-fixations.

General Stimulus Event Comparisons

Ranking of sector preference was significant beyond the .01 level for all data groups. Uniformity of image processing was moderately high for the Non-Congruent data group, moderate for the Expert and Congruent data groups, and low for the Free-Viewing data group.

•$W_{(NCG\text{-}S)}$ =.7590 & $W_{(EXP)(CG\text{-}S)}$ of <.5718 & $W_{(FR\text{-}S)}$ =.4633

Congruency Comparisons

The Degree of Congruency (°**CG**) between what the Experts identified as structural strengths in the image and how the Free-Viewing data group viewed the image was high, $°\mathbf{CG}_{(EXP|FR\text{-}S)}$ **=83**. The match between the Free-Viewing data group and the Congruent data group was high, $°\mathbf{CG}_{(FR\text{-}S|CG\text{-}S)}$ **=82**, and the match with the Non-Congruent data group was moderate, $°\mathbf{CG}_{(FR\text{-}S|NCG\text{-}S)}$ **=69**.

Structural & Contextual Dominance Comparisons

A weak congruency effect was evident in the Congruent data group in sector **H** ($\mathbf{D}_{H(CG\text{-}S)} = \mathbf{38}\%$). A strong contextual effect was evident in the Non-Congruent data group in sector **B** ($\mathbf{D}_{B(NCG\text{-}S)} = \mathbf{40}\%$). A definite focus on the center of the image was evident in the Free-Viewing data group ($\mathbf{D}_{E(FR\text{-}S)} = \mathbf{43}\%$). Similar to the preceding image, if in fact the actual structural dominance for image 14 is in sector **E**, as is evidenced by the Free-Viewing data group, then both the Congruent and Non-Congruent data groups demonstrate contextual effects rather than congruency effects. However, it may also be said that both groups represent partial congruency effects, since both sectors **B** and **H** represent secondary and tertiary structurally dominant sectors.

Between Image Results

The 15 image stimuli presented were grouped into 3 subgroups; 5 simple, 5 moderately complex, and 5 complex images. The Kendall Coefficient of Concordance measures the uniformity of the subjects' responses. The Kendall W (W) is a rating as to how similar each subject's response was to other responses such that if they were identical, the W would be 1. Figure 8 illustrates the general decrease of uniformity of the experimental groups as the complexity of the image increased.

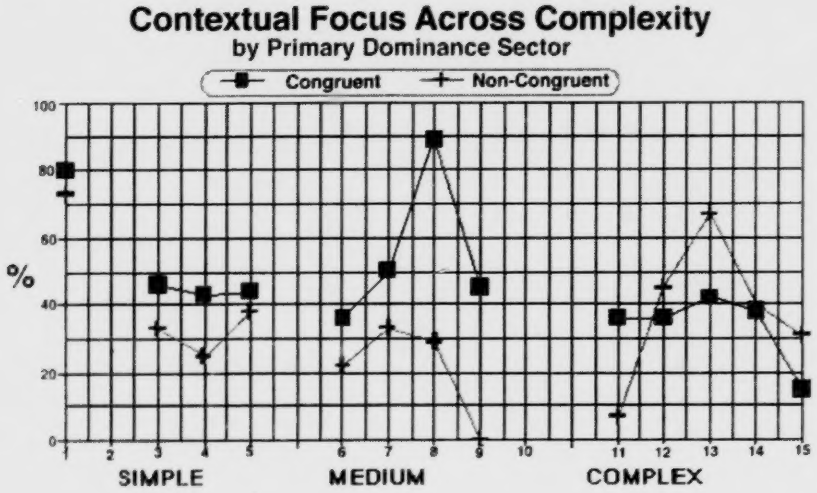
Uniformity by Complexity

The Experts (EXP) began with very strong agreement (.9) and, as the complexity of the image increased, their average uniformity dropped, but still remained in the strong moderate range (.6). The Free-Viewing Group (FR-S), on the other hand, began in the moderate range (.6) and finished with a low uniformity W (.42). The congruent and non-congruent conditions (CG-S & NCG-S) displayed lessening uniformity as complexity increased, but stayed in the moderate range.

Comparisons by Primary Dominance

By plotting the dominance of the contextually dominant sector of both the Congruent and Non-Congruent data groups, a comparison of the focus of these groups may be made (Figure 8).

Figure 8



It is evident in this graph that the Congruent data group consistently exceeded the Non-Congruent data group's focus on the contextually important element of the image for the simple to medium complexity images. It is also apparent that with images 12, 13, 14, and 15 (within the Complex category), the Non-Congruent contextual dominance exceeded that of the Congruent data group.

Another observation evident from the graph is the strong congruency effect for the moderately complex images. It was with the images dealing strongly with visual conventions that the Congruency Effect was most evident, e.g. that structural dominance, coupled with contextual dominance, had the greatest effect. Contextual dominance alone contributed more with the complex images.

Conclusions

Response to the Specific Experimental Hypotheses

[H1]The first experimental hypothesis posed was that congruency between dominant structural elements and dominant contextual elements would result in greater attention to these congruent elements than in non-congruent situations. The statement, in terms of this experiment, looks specifically at the contextual dominance generated in each of the Congruency data groups. This dominance represents not only a contextual effect, but also the contribution of a structural effect as well. Because of the combined effect, it is called a congruency effect. In the Non-Congruent data group the dominance primarily represents the contribution of a contextual effect. In 69% of the cases, a focus on the contextually dominant element of the image was stronger when that element was also structurally dominant

A Congruency Effect was particularly evident with the moderately complex images, where the average dominance was 34% higher than that in the Non-Congruent condition. These results lead us to a conditional acceptance of the first hypothesis. If the structural dominance is strong, then congruency between structurally dominant elements and contextually dominant elements will result in greater attention to these elements than in less-congruent situations.

One image was exemplary in demonstrating Congruency Effects -- image #8. Reviewing the structure of this image and context will clarify the types of "strengths" referred to above. The word "sky", heard in one group's contextual phrase referred to three sectors, A, B, & C, which were clearly related to the upper third of the image. The other group heard the word "base", which refers to the lower third of the image. The action verb, "points," which was heard by the Congruent data group, coincides with the visual convention of an arrow (which a pyramid shares in shape) that reinforces the congruency between contextual cue and image structure. The fact that the object was an isosceles triangle rather than an equilateral one increased the "pointing-up" effect even more (DB(CG-S) =89%). The Non-Congruent data group was directed to the base of the triangle by the contextual cue, but they had to overcome the strong image structure "pointing-up" to attend to the base. A very small portion of their dominance was devoted to the base area of the image (DH(NCG-S)=29%). This image produced the greatest Congruency Effect. It also demonstrated a strong Structural Effect evident in the inflation of sector B in the Non-Congruent data group (DB(NCG-S)=43%). There is little or no explanation for such dominant fixations to occur in this group except for the fact that the image structure was so strong as to draw fixations into sector B.

[H2]The second experimental hypothesis stated that, as complexity of an image increases, the structural dominance will decrease. Across the 15 images there was a continual trend downward in uniformity of agreement of structural dominance by the Experts. These results in uniformity, and loss of agreement on structural dominance, support the second hypothesis. Specifically it provides evidence that, at least with these images, as elements of equal or greater structural value are added to an image, the structural dominance declines in strength.

[H3]The third hypothesis was whether or not structural dominance is inversely proportional to the contextual effect; or, as structural dominance decreases, does the contextual effect have a greater impact on the attention patterns of the observer? With the information just presented on uniformity, if the hypothesis is true, then one would look for an increase in the contextual effect from the more complex images where uniformity was low, as was the structural dominance.

Referring to the graph in Figure 8, this hypothesis is supported by the Non-Congruent data group's performance exceeding that of the Congruent data group for images 13 through 15. As was mentioned in the detailed description of the complex images, the structural dominance was so illusive for the Experts that the primary dominance they indicated for the complex image set never matched that of the Free-Viewing data group. This success rate may be compared to a match of 60% in the moderately complex image set (images 6 through 10).

A case in point is that of image #14. One of the Experts described the way he thought that persons viewed a photograph was spatially (e.g. the same way one would if he were to be walking in that space). In other words, one would look at the first thing one would come to, then the second, then the elements surrounding one's immediate space, then beyond (in the case of image #14 this would produce an H, E, B progression of D). Another Expert suggested that, since everything was arranged symbolically in a hierarchy from God, to Christ, to the sheep, and finally down to common man at the altar level, that the viewing patterns would coincide with that order (or a B, E, H progression of D). In fact, the viewing was more determined by the context presented by the verbal cue. The progression of D was H, E, B, D for the group which received a contextual cue relating to the alters at the bottom and center of the image, and B, E, A, H for the group which heard reference to the illustration in the half dome. This supports the third hypothesis that, as the structural dominance decreases, the context becomes more important as to where one focuses attention.

This finding would be supportive of the majority of research to date in the area of complexity, which states that simpler visuals are more predictable and memorable (Loftus, 1972; Luder & Barber, 1984; Friedman & Liebelt, 1981; Palmer, 1975; Heuvelman, 1987). New information is offered from this experiment regarding the relationship of Expert predictions, Congruency and Free-Viewing situations in terms of complexity. These variables have not been compared in the past.

The Concepts of Structural and Contextual Dominance

A major contribution of this study is its identification of Structural and Contextual dominance as factors which define Congruency, accompanied by a methodology for measuring them. Many studies have identified the structure of an image as being a variable (Heuvelman, 1987; Marschalek, 1986; Koroscik, 1984; Nodine, 1982; Molner, 1981 Nesbit, 1978; Dwyer, 1972), but none have defined it in terms of dominance. Many of these same researchers have presented a verbal or written phrase as a contextual setting to provide semantic encoding of the image, but none have compared contextual and structural dominance directly.

To the visual designer, the structural aspects are of utmost importance, since these are the elements that are being manipulated. The sad part is that messages are designed without attention to the structural dominance, or visual design, and because of their incongruity with the message, are ineffective. Research is done without concern to this very strong interacting variable, and inconclusive results are the outcome. The sooner that structural dominance takes its place beside contextual dominance as an equal contributor to the message, the sooner we will begin unraveling many of our communication issues involving images.

The Concepts of Congruency and Complexity

The finding in this study that Congruency Effects were strongest in the moderate complexity range supports Heuvelman's and Koroscik's finding that congruency can be higher with more abstract images. This appears particularly true when familiar visual conventions are used at this level of complexity. This study only partially supports other findings from these researchers that realistic or highly complex images distract to such a degree that congruency cannot be achieved. This study supports these views only when the stimulus consists of a weak contextual dominance coupled with a strong structural dominance. In these situations the dominance of the image takes over, and the contextual thrust is lost. However, this study also demonstrates that, especially in complex images, if the contextual dominance is strong and if the visual referents that are elements of the weaker structural dominance are also to by found within the image, then a contextual effect will also be strong, because of the contribution of a small congruency effect.

Summary

This study illustrates that when the structural dominance of an image is strong, an individual viewing this image will initially attend to the elements contributing to structural strength rather than to those which are contextual. The intent of most educators, in the presentation of an image, is mostly contextual. If a learner who rates low in knowledge of, and motivation toward, the specific information being presented, and if the image used is strongly structured in favor of a different context than that which the instructor intends, then the chances are high that the learner will not process the image in a desired manner. If this lack of congruency continues during a presentation, confusion on the part of the learner will be the most likely outcome. The converse of this situation is the desirable state of affairs. Instructional designers must gain adequate respect for the structural dominance issues, as the majority already have for the contextual dominance ones. The chances that learners encountering instructional messages will find the pathway to knowledge must greatly be enhanced. Most instructional designers do not have the skills necessary to analyze the structural components of an image to determine the structural dominance. Graphic designers, and a newly forming role called an interface designer (mainly involved with electronic media production), do have these skills, but most often are not adequately informed in the subject matter or instructional strategies to determine the appropriate contextual dominance. A team effort is necessary to assure that both aspects of the instructional development are adequately pursued. The inherent problem is that one person talks context while the other talks structure, and no progress is made. This study opens the door for communication between these two important people utilizing the rubric of Dominance. If both the instructional designer and the interface designer respond to each others' products in terms of the "dominance perceived," not only will the dialog be more fruitful, but the learner (who will be the ultimate "perceiver") will also be brought into the process.

Placement of the message along a quantitative to qualitative continuum becomes a negotiation item for the "team." The interface designer will inherently be an advocate for more qualitative messages at one end of the continuum, while the instructional designer most likely will support more quantitative solutions at the other. Villemain (1966) supports the need for both in his statement that, "Qualitative mediations are instrumental to focally cognitive operations at one end of the spectrum, while on the other they become focal with cognitive elements assuming the instrumental role."

Major work to be done in research is in the field of art, not to quantify it and make it rigid, but instead to understand it adequately enough to incorporate it into the message design. The extent that anyone creating a message desires a level of perfection in communication, is the degree to which one embraces a desire to deal with the total continuum from information to art. Let John Dewey's challenge be our motivation:

> *As long as art is the beauty parlor of civilization, neither art nor civilization is secure... the ideal human community is dependent upon its esthetic component. Rather than envisioning art as an "efflorescence" , it is a condition of the realization of democracy, conceived as an ideal that lends a distinctive character to all aspects of life. If such a view is tenable, then significant revisions in democratic educational and social theory are in order. (Dewey, 1934)*

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Title:

Establishing a Research Agenda: Perspectives of New Faculty

Panel:

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Responder

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Introduction

Given the present emphasis on research and publishing at many institutions of higher education, and given the dire need for "socially responsible" research that can contribute to effective practice in many types of learning environments, and given the contribution research can make to the professional vitality of instructional technology faculty, a panel of new faculty offer here the challenges they have faced and lessons they have learned in attempting to create a research agenda for themselves.

To provide a point of reference, a brief biographical sketch will be provided of the panel members and the responder. Then, the panelists' comments will be sorted around several principle topics that emerged as we each individually developed our panel presentations. Note that not all of us addressed every topic. Finally, the responder's insights and recommendations will provide closure to the topic.

Biographical Sketches

Dr. Molly Baker is a "practicing" instructional designer at Western Illinois University. She is in her third year (2nd year since Ph.D. completion) serving the faculty in 12 departments who are learning how to use technology in their instruction and develop hands-on technology experiences for their students. Through the Faculty Instructional Development Lab which she runs, faculty are encouraged to participate in workshops, one-on-one consultation regarding course design, multimedia development teams, individual lessons on a host of technology-based activities, grant writing for technology resources, etc. Her research agenda is driven by urgent need-to-know questions and practical issues of technology utilization/integration.

Drs. John Farquhar, Jim Quinn, and Steve Harmon are assistant professors at universities who adhere to the tenure-track system which rewards good teaching, an active research program leading to publication, and service activities. They are in their 3rd, 4th, and 5th years respectively. Dr. Quinn has been employed at a large, research-oriented institution and the Drs. Farquhar and Harmon have been working at institutions where teaching and research are more evenly balanced. Dr. Reeves is a Senior professor at the University of Georgia, is widely published in the field of Instructional Technology, and has focused some of his recent writing on the need for more "socially responsible" research in the field.

Perspectives of New Faculty: Building a Research Agenda

Tip #1: Build Skills and One Research Focus Through the Dissertation

Molly Baker:

When I began thinking about a research question for my dissertation, I identified three criteria: My question must suggest a methodology that would be do-able within a reasonable period of time; it must be interesting to me (since I was likely to spend a large chunk of time on the task and build several years of follow-up research as a new faculty member on it, as well); and lastly, it must be valuable to professionals other than myself--I wanted it to contribute to the field in some meaningful way. It took months to find such a question and my dissertation chair suggested at one point that I might have to give up on one of my criteria!

Now I find that as an instructional designer, the problem is not finding a researchable question at all--I can identify a couple every day on the job! The problem is identifying which ones to pursue, and finding the time and resources to do it. The research skills I developed in graduate school have been essential, but the research focus (effective teaching on interactive television) that I anticipated has been greatly expanded by the demands of my position.

John Farquhar:

In retrospect, my research as a doctoral student should have positioned me to perform a series of related, follow-on studies. My dissertation involved the study of an instructional strategy common in the design of Intelligent Tutoring Systems (ITS). At the time of my defense, I was well versed in the ITS literature and the significance of my work. Additionally, I was pleased to have guided the study so that additional research questions were naturally to follow. Yet, despite this fortune, I have taken a different, less-traveled path.

During the final phases of my work on the dissertation, I became a very focused, one-issue researcher. I intentionally isolated myself physically and intellectually from the Instructional Technology community in order to achieve this focus. I found my isolation to be a necessary strategy that kept me on track to graduate. The advantage of the strategy was immediately evident in the form of a successful (i.e. completed) thesis. The disadvantage of the strategy did not readily appear to me until many months later.

Steve Harmon:

It all started in the winter of 1986. I was teaching English as a second language in a developing country and was coming to the end of my two-year contract. I knew that I wanted to continue to work in some way with developing nations, and needed a graduate degree to do so, but I didn't want to do the same old development stuff that every body else was doing. I stumbled into something called instructional design and realized I had found my place.

In the Fall of 1987 I enrolled in the Instructional Technology department at the University of Georgia. My intention was to focus on Instructional Systems Design, with an eye toward working in developing nations, but along the way I got sidetracked. I became interested in a new technology called hypermedia. Four years and a couple of studies later, I was hired as a lecturer in Instructional Technology at the University of Houston-Clear Lake. I had not yet finished my dissertation, but had collected my data and was in the process of writing it all up.

Tip #2: Choose An Institution/Environment That Fits Your Interests

Jim Quinn:

If you are already in a faculty position, you already should know what the balance of teaching, research and service is in your institution. If you are a graduate student (or even if you are already in a faculty position), you may still be deciding what balance you want in your career. For example, for some of us, we are in positions where research is the primary criterion on which we are evaluated for promotion and tenure, while others are in positions where teaching is the primary criterion on which we are evaluated. However, irrespective of the type of institution we are in, we will all have some research/creative activity requirements. Therefore, my first suggestion is for you to consider what would be the best type of institution for you to work in given your interests and training. If you wish a considerable amount of your time to be involved in day-to-day interaction with students, teaching classes at the undergraduate and masters level, you may wish to consider an institution where teaching is the number one priority and research is the number two priority. However, you should be aware that in such institutions, you are going to have to be involved in some research/creative activity. On the other hand, if you find yourself primarily excited by being involved on a continuous basis in research projects, supervising Ph.D. students, etc., then you may wish to seek employment in a major research institution.

Tip #3: At First, Watch for Research Problems and Resources as You Deal With the Onslaught of Demands

Tip #4: Then, Select Research Projects From These Identified Possibilities and Resources

Jim Quinn:

It is impossible to be perfect in teaching, research *and* service, and sometimes it seems to me to be impossible to reach the required level of performance that is expected of all new faculty in each of these three. Therefore, the more we can do to integrate each of these the better. For example, in my case, I am very interested in the philosophy of instructional design and the subsequent implications of such a philosophy for how we educate instructional designers. I have been involved in attempting to integrate theory and practice in instructional design by having students in my advanced instructional design course be involved in real-life projects as their course projects. While I am aware that other faculty in many institutions have been doing this for a long time, I was not aware of any publication on this issue, so I wrote up a report on this for ETRD which was recently published. Since then, I have done one more research study on a subsequent iteration of this course in a more formal research manner using qualitative research techniques and I am currently working on this data. I have also been using peer evaluation extensively in my introductory level course and have collected data on its effectiveness through focus group interviews and am preparing this for publication. I have seen similar good empirical work being done on the education of instructional designers by people such as Peggy Ertmer and her colleagues at Purdue recently on the use of case studies in the education of instructional designers.

Steve Harmon:

That first year out of graduate school was an eye-opener. I had worked hard at Georgia and was reasonably competent in my areas of interest. I could conduct and evaluate research. I could design and teach courses on a couple of topics. I even had some idea about writing and presenting papers. My research agenda was set; finishing my dissertation was my primary concern. (Incidentally, as it turns out, it was on hypermedia.) Much to my surprise, my graduate preparation had not covered what I ended up spending most of my time on.

I had encountered what I now call "the Janis Phenomenon," after the Janis Joplin song "Take Another Piece of my Heart." Far from being able to work happily away on my dissertation, locked safely in my ivory tower, I was suddenly besieged by a host of "real-world" concerns for which I was totally unprepared. These things were like giant sponges sucking up all of my time. I'd like to spend the rest of this discussion going over those concerns and how they drove my research agenda for the next few years.

The first thing for which I was unprepared was students. I had had students in grad school of course, but then they were mostly safely contained in classes. The students I had now were roaming free. They wanted me to advise them. They wanted me to help them. And some of them wanted me to tell them what to do with their lives. I quickly learned why several of my professors kept a box of tissue in their offices. I had become some kind of counselor. I didn't have time for that.

The next thing I was unprepared for was colleagues. In graduate school I had called them faculty, and mostly encountered them when they were safely contained in classes. I only had to deal with them then or when I chose to trap them in their offices and force them to give me advice. But now these people had offices right next to mine. And because I was an instructional technologist they figured I knew something about computers. I began to get a constant stream of colleagues coming in to get me to show them how to plug in a mouse. And who knew which ones would ultimately be on my promotion and tenure committee. I didn't have time for that.

The third major thing I was unprepared for was the Dean. I had never had a dean before. In graduate school the dean was someone who had a big office on the first floor and was either revered or reviled depending on who you talked to. The only time I ever saw the dean in graduate school was once when I had to go show him how to plug in his mouse. Now I had this Dean who actually knew who I was and who wanted stuff from me. I quickly learned that the translation of the word "dean" in the real world is "boss." The dean wanted me to deal with my program ("increase enrollment, specify competencies, tighten-up evaluation of graduates"). He wanted me to deal with the school ("increase enrollment, bring in grants, train other faculty"). He wanted me to deal with the university ("give me an example of the great things you are doing to show the president"). He wanted me to do a hundred other things at the same time. And of course, I didn't have time for that.

I spent the first few years trying to meet all of these demands on my time. My research agenda was dictated by the demands of the Dean. He had me and several other faculty working on a major grant that didn't involve hypermedia. What time I had outside of that was quickly taken by one of the other demands. I seemed to have a choice of either giving up research in hypermedia or giving up support from the dean. In other words, I was demanded if I did and demanded if I didn't.

Over time I became interested in what the Dean was having me work on (systemic change). I didn't lose my interest in hypermedia, but instead found it modified to fit in with my other concerns. More importantly, I began to see how all of those things which had prevented me from getting a research agenda going were really assets which could greatly aid my research. The table below presents the time sponges I originally saw as liabilities and how I now view them as assets.

Time Sponge	**As a Liability**	**As an Asset**
Students	Need Advising Need Extra Help Need Counseling	Can Conduct Research Can Challenge You
Faculty/Colleagues	Want Expertise	Can provide expertise Can provide advice
Classes	Take Time for Preparation, Delivery, and Evaluation	Can provide Subject/ Environments for Research Can be test ground for disseminating research
Program	Requires time and effort in recruitment and improvement	Can attract better students Can enhance reputation Can provide more colleagues
School/College	Requires time and effort to support initiatives	Can provide resources for research Can provide environment for research
Committees	Hold seemingly endless meetings dealing with seemingly trivial things	Often control resources (money, equipment, space) needed to support research
The Community	Wants expertise and free advice	Can provide real world problems to study Can provide resources
The Profession	Requires time and effort for organizational involvement, journal/book reviews, etc.	Can provide expertise, resources, advice, real problems, reputation, etc.

In short, what I found was that while external factors seem to drive my research agenda, I have begun to learn to steer. Currently I am interested in creating learning and performance environments on both a macro and a micro scale. On the micro scale I want to build multimedia/hypermedia based rich learning environments for individual or small groups of students. On the macro scale I want to create organizational environments in which these micro scale programs can be implemented successfully. This organizational development is based on the systemic change effort that was required of me by the dean. Rather than lament all of the conflicting demands on my time, I now seek to organize these demands so that they can be met while at the same time supporting my own research agenda. It is possible to discover a real synergy in academia, if one is not torn apart by it first.

John Farquhar:

The transition from doctoral student to faculty member is abrupt. Within a few days of the final dissertation defense, I began my career as a faculty member, preparing for new courses and advising students. Even with a reduced teaching load, I spent my first year almost exclusively on course preparation.

It was in January of 1995, 5 months after I started my faculty career, that I received a shock. I had just become aware of the ease of publication on the World-Wide Web. My recognition of the potential impact of this new technology hit me like an oncoming train from behind. I was not prepared to accept that many new and exciting, "cutting-edge" developments had completely escaped my field of vision. At the time, I felt antiquated and depressed.

I now recognize that the World-Wide Web is perhaps the fastest growing technology in all of history and continues to hit many people by surprise. Additionally, I found that the design and development skills I already possessed were easily transferred to the new medium. My new research activities are now largely interested in the instructional viability of networked, computer-mediated communication.

At this point in my career, I am still trying to recover from the isolation I experienced during my dissertation. Additionally, I am still attempting to regain the research momentum that I lost when I began teaching full-time. Lessons to be learned from this experience are (1) isolation from the field for even short periods of time can have a significant impact, and (2) the momentum of dissertation research can easily be lost when starting a new position.

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Molly Baker:

Like Steve, I began my first position while I was still working on my dissertation. The demands of the job were constantly competing for the time I needed to complete my research/writing. As I attempted to juggle everything, I began to realize that although my primary research interest would likely remain effective teaching on interactive television (the central focus of my dissertation and part of my job, as well), there would also be many other urgent and important avenues to pursue. During that first year when all I could manage was doing my job and getting my dissertation completed, I started a "research ideas" journal which included:

potential research questions/topics as they occurred to me as spin-off projects from the dissertation
potential research questions/topics as they occurred to me through working on real-world problems in my job
potential research questions/topics as they occurred to me during my reading in the literature (both professional and more "popular")
potential research resources, including:

- potential research partners on the faculty at WIU
- potential research partners elsewhere
- bright graduate students
- support personnel that could help me with various aspects of research
- within-institution grants to support research activities, especially in the summer
- potential publishing outlets (journals, professional magazines, newsletters, books, etc.)
- important dates that might impact research or opportunities to share results, such as conferences, grant deadlines, on-campus events, etc.

As a result, I have lots of ideas for dissertation spin-off questions I would like to examine; however, the real demands of my job as the primary academic support person for faculty teaching courses on our interactive television system at WIU has helped me select specific projects that will reap immediate rewards in terms of enlightening future training of faculty or their effective practice as distance teachers.

Additional research activities have also emerged out of the many other daily demands of my office. Sometimes I get no further than doing a quick Internet search or literature review on topics such as consulting practice, multimedia development teams, innovation adoption, or facility design for teaching with technology. Other times, I pursue activities that have urgent "need-to-know" implications for future planning. For example, I may conduct extensive needs assessments/surveys or in-depth interviews to understand the immediate needs and interests of "my" faculty so that I can better plan a range of services and workshops for them. I may plot a formative evaluation/journaling activity during the development phase of a multimedia development project to better evaluate my role and that of my graduate students in supporting faculty in such endeavors in the future. I regularly do a variety of evaluation and feedback activities following workshops and individual lessons I conduct, with the specific goal of improving future hands-on faculty development activities. Additional job demands that prompt research activities are grant evaluation activities and requests from the Dean's office or College of Education's technology committee for informed guidance on planning initiatives.

Tip #5: Seek Out Others to Collaborate With on Research Projects

Jim Quinn:

Do not try to be a lone ranger. If you have graduate students who are willing to work with you on research projects, make use of such willingness. They will get experience in doing research and you will get help in running research studies. In my experience, I have found it to be of great value to have two to three research students working with me in running empirical research projects.

Whether or not you have graduate students available to work with you, you may also have colleagues who are willing to work with you on such projects. Finally, on a broader level, keep in contact with other new faculty that you meet at conferences such as AECT, AERA, etc. - such networking offers great possibilities for the kind of collaboration that we are talking about here.

On a similar note, involve people who have skills that you may not have. In my case, in particular, I am thinking of someone who has skills in qualitative research, which I am not expert in. I, like many other instructional designers it seems, have been primarily trained in quantitative techniques and a significant amount of the research I have been involved in has required knowledge of various qualitative techniques, and I have been very fortunate in working with someone who is knowledgeable in such techniques.

Steve Harmon:

See Table in section on Tip #4 and #5 for suggestions.

Molly Baker:

I have found it a challenge to find research collaborators. Our master's program, for example, offers a non-thesis option for our students, and most of them choose it, so I virtually have no graduate student assistance for research activities. Additionally, the faculty in my department have their own research agendas which do not seem to overlap much at all with mine. However, I have recently identified some faculty in two other departments with interests that may blend with mine, so there may be hope for future collaboration. Likewise, I have struck up a wonderful relationship with another instructional designer that I met through the distance education listserv (DEOS-L) and we are planning on doing some joint projects. Also, I have a few in my "research journal" that I have not sought out yet.

Tip #6: Develop Discipline for Writing

Molly Baker:

My biggest challenge in sharing my research findings with the wider field of instructional design is time. As the technology activities at WIU have grown and my specific responsibilities have expanded, I no longer have blocks of time to write. I must do that on my own time at home, which for a non-tenure track faculty member is after hours or weekends. I am not free to leave for part of a day to write and I have a large family at home. I am searching for a solution to this problem this year--including more self-discipline on my part! I have a friend, for example, who writes every day from 7:30-10 and does not open his office door until then. I do conduct many presentations at conferences and other events which put me in contact with other ID professionals and give me an oral opportunity to share, at least, and I plan to continue that. The linear process of research, presentation, paper, and publication makes sense to me. I just need to find a better system to get the last two accomplished.

Establishing a Research Agenda:
Social Responsibility, Politics, Goals, Methods, and Practical Steps

Dr. Thomas Reeves

Socially Responsible Research

Although many mainstream academic researchers will disagree, the foremost criteria for establishing a research agenda in the field of educational technology should be "social responsibility." Socially responsible research "addresses problems that detract from the quality of life for individuals and groups in society, especially those problems related to learning and human development" (Reeves, 1995, p. 2). A more traditional view of the purpose of research is captured in this statement by Fred N. Kerlinger (1986), author of one of the best-selling educational research textbooks:

This discussion of the basic aim of science as theory may seem strange to the student, who has probably been inculcated with the notion that human activities have to pay off in practical ways. If we said that the aim of science is the betterment of mankind, most readers would quickly read the words and accept them. But the basic aim of science is not the betterment of mankind. It is theory. (p. 9, Kerlinger's italics)

However, in light of the enormous problems faced by learners, teachers, and trainers around the world as well as the lack of impact that basic research has had on educational practice, basic research in an applied field such as educational technology is a luxury society can ill afford. (Of course, basic research in related fields such as cognitive psychology may be supported.) A socially responsible view of the purpose of educational research is represented by this statement by Robert Ebel, a past president of the American Educational Research Association (quoted in Farley, 1982):

> ....the value of basic research in education is severely limited, and here is the reason. The process of education is not a natural phenomenon of the kind that has sometimes rewarded scientific investigation. It is not one of the givens in our universe. It is man-made, designed to serve our needs. It is not governed by any natural laws. It is not in need of research to find out how it works. It is in need of creative invention to make it work better. (p. 18, Ebel's italics).

Along with other investigators, educational technology researchers are usually required to submit their research proposals to human subject review committees at their institutions. Education faculty and graduate students often complain about the "onerous" task of completing this "paperwork" which is meant to ensure that research activities do not harm humans. Despite these complaints, I propose that universities and other institutions extend these reviews to include "human benefits" criteria. Specifically, if educational researchers cannot demonstrate how their research will benefit human learning and development, it should not be approved for implementation using institutional resources. If a human benefits review was taken seriously, I predict that much of the pseudoscientific research that characterizes education would be exposed and eliminated. (I also predict that such a review process will never be implemented because of the political investment that education faculty have in the status quo.)

The Politics of Educational Research

Honest educational researchers in colleges of education will admit (albeit not as publicly as Bracey, 1987, quoted in Sykes, 1988, did) that the primary reason they conduct research is so that they will have something to publish in research journals, and thereby attain promotion and tenure. Winning the "publish or perish" game is the ultimate goal of most faculty, and the game itself is behind the rapid proliferation of research journals and conferences in recent years. The "peer review" process that should guarantee that only valid research gets published has been corrupted by the sheer number of outlets for "scholarly" publication. In turn, the review processes adopted by tenure and promotion committees are based upon quantitative criteria such as counting the number of refereed journal articles an applicant has listed in his/her vitae. These committees rarely have any members who could evaluate the quality of these research studies even if they had the time and motivation to do so.

Given the nature of the game, it is not surprising that new faculty are often told: "get your hands on some data" and "publish it everywhere you can," as I was when I was a newly-minted assistant professor. Virtually no one directed me toward the enormous problems that confront educators and trainers in every corner of the globe. Ideally, new faculty and graduate students would be mentored into socially responsible research agendas by experienced faculty, but the sad truth is that many of the latter, having "won" the corrupt tenure and promotion game, are too exhausted, jaded, and/or demoralized to continue with research unless it leads to higher accolades or substantial pay increases.

The Goals of Educational Research

So what is the educational technology faculty member or graduate student to do to establish a socially responsible research agenda? First and foremost, you must be clear about your goals beyond the mere fact of academic survival. In short, you must decide on the type(s) of research goals to which you can ethically devote yourself. Here is a partial list of research goals appropriate to the field of educational technology.

Theoretical: A research agenda with theoretical goals is focused on explaining the phenomena of human learning and development through the logical analysis and synthesis of theories, principles, and the results of other forms of research such as empirical or interpretivist studies.

Empirical: A research agenda with empirical goals is focused on portraying "how" education works by testing conclusions related to theories of human communication, learning, performance, and the use of technology.

Interpretivist: A research agenda with interpretivist goals is focused on portraying "how" education works by describing and interpreting phenomena related to human communication, learning, performance, and the use of technology.

Postmodern: A research agenda with postmodern goals is focused on examining the assumptions underlying applications of technology in human communication, learning, and performance with the ultimate goal of revealing hidden agendas and empowering disenfranchised minorities. The postmodern researcher often subscribes to a particular political perspective, e.g., feminist, neomarxist, or multicultural.

Developmental: A research agenda with development goals is focused on the creation and improvement of innovative approaches to enhancing human communication, learning, and performance through the integration of technology, theory, and imagination.

Action: A research agenda with action goals is focused on evaluating a particular program, product, or method, usually in an applied setting, for the purpose of describing it, improving it, or estimating its effectiveness and worth. Action research often directly serves the needs of clients in education and training.

Over the course of my career, most of my own research has been driven by developmental or action goals. I have found this to be personally fulfilling, and in the final analysis, I believe my research agenda has had more positive impact on real needs than I would have had if I had devoted my energies to theoretical or empirical goals. This is not to say that my research agenda has not been shaped by the theoretical, empirical, and interpretivist work of other researchers, but very little if any of this influence has come from within our field. Unfortunately, there has been very little interpretivist research in educational technology, and much of the research that might be said to have theoretical or empirical goals amounts to pseudoscience (Reeves, 1993).

The Methods of Educational Research

Once you have decided upon your goals and identified a meaningful research problem or question, you are ready to choose your methods. Choosing research methodologies is a complex process that has as much to do with your personal epistemology as it does with the nature of your problem or question. Whether you are an empiricist, a constructivist, a critical theorist, or a chaos theorist will have an major influence on your preferred methods of inquiry. Here is a partial list of research methods used in our field:

Quantitative: You may use experimental, quasi-experimental, correlational, and other methods that usually involve the collection of quantitative data and its analysis using inferential statistics.

Qualitative: You may use observation, case-studies, diaries, interviews, and other methods that usually involve the collection of qualitative data and its analysis using grounded theory or other ethnographic approaches.

Critical Analysis: You may choose to engage in the critical deconstruction of "texts" and the technologies that deliver them through the search for binary oppositions, hidden agendas, and the disenfranchisement of minorities.

Literature Review: You may engage in various forms of research synthesis that usually involve the analysis and integration of other forms of research, through methods such as content analysis, frequency counts and meta-analysis.

Mixed Methods: You may develop research approaches that combine two or more methods, usually quantitative and qualitative, to triangulate findings related to a particular problem or question.

Practical Steps

How do you get started with a developmental or action research agenda?

First and foremost, you must identify the needs in your environment. Spend a great deal of time in other colleges, K-12 schools, and/or business and industrial training centers. Frankly, in an applied field such as ours, I think faculty members and graduate students should spend at least two days a week in the field. After spending time with them, you will perceive the real problems faced by practitioners. Make their challenges your challenges.

Second, collaborate with other educators and trainers in preparing research and development proposals to find the resources needed to tackle these challenges. Once you obtain the necessary resources, engage yourself and your students in these R & D projects, and carry out your research activities within the context of meeting these challenges. You can even extend your teaching into these projects by engaging students in assignments that are situated within them.

Third, write something every day, whether it is a memo to yourself about a new idea, an e-mail message detailing your progress to a colleague, or an outline for a scholarly paper. Back-up everything electronically and set yourself specific goals for writing scholarly publications for periodicals and other outlets. Given that the editorial and review boards of many refereed journals remain mired in existing paradigms, look for opportunities to publish your work in practitioner-oriented magazines, electronic journals, and edited books.

Fourth, carefully document your scholarship and obtain frequent assessments of its value from the clients with whom you work. Although tenure and promotion committees may still count the number of refereed journal articles you have, I believe that a well-documented portfolio of scholarly work that is also socially responsible will not be ignored. Architects, artists, and others in academe have developed alternative criteria for judging scholarship in their fields, and it is time for educational technology to do likewise.

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Title:

The Effects of Preinstructional Activities in Enhancing Learner Recall and Conceptual Learning of Prose Materials for Preservice Teachers in Zimbabwe

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It has been argued that organization is the hallmark of good instructional materials (Gagne´, 1965). Given the emphasis on prose and written materials in most educational systems, the sequencing and arrangement of subject materials appears to influence not only what students learn, but also their attitudes towards the efficacy and importance of instructional materials. Nowhere is this more important than in the preliminary phases of the design and development of instructional materials.

Hartley and Davies (1976) state that in addition to an efficient organization of instruction, good teaching and a well organized "bird's eye view" of a task supplies the learner with a useful perspective of what will subsequently be encountered. This type of cognitive organization helps the learner to integrate new ideas and experiences with what s/he already knows.

A review of the results of previous studies obtained shows that recall and conceptual learning of prose materials are facilitated by the use of advance organizers, behavioral objectives, orienting questions, pretest and posttest questions, reviews, and lesson prefaces (Allen, 1970; Ausubel, 1960; Ausubel & Youssef, 1963; Barker & Hapkiewicz, 1979; Duell, 1974; Huck & Long, 1973; Peleg & Moore, 1982; Rothkopf & Kaplan, 1972). When designing and developing instructional materials, a great deal of emphasis is placed on instructional strategies that serve as a basis for learner orientation.

The learning models by Bloom (1956) and by Krathwohl, Bloom & Masia (1964), classify instructional objectives into taxonomic categories. Gagne´ et al. (1988) classified criterion-based human performance into five categories: verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. In order to optimize learner performance in all the conditions of learning, he proposed the application of a nine-step process called the events of instruction. Events 1,2, and 3--gaining attention, informing learners of the learning objective, and reminding learners of prerequisite skills,--respectively fall within the rubric of preinstructional activities. The preinstructional activities investigated in this study were advance organizers, performance objectives, and structured overviews.

Advance Organizers

Studies carried out during the past 30 years present a diverse and sometimes conflicting scenario on the facilitative effects of advance organizers. Over 100 studies have investigated the effect of the Ausubelian organizer at one time or another since Ausubel's (1960) preliminary experiments (Luiten, Ames, & Ackerson, 1980). In spite of the conflicting results on the efficacy of the advance organizer, an analysis of well-designed studies suggests tentative support for the organizer technique, especially if the instructional materials are not well-organized to begin with and the target learners have limited prior knowledge of the subject matter.

Variations in the types of organizer tasks, recall and comprehension measures, validity and reliability measures, and student characteristics have broadened the range of available data. This has resulted in methodological and theoretical implications that at times are at variance with Ausubel's advance organizer theory. An important component of this study was to narrow the definition of the advance organizer in order to make it easier for it to be operationalized.

Performance Objectives

Research on performance objectives began 50 years ago. In excess of 100 studies have investigated the effect of prescribing behavioral objectives prior to instruction. The metamorphosis of performance objectives is reflected by the variety of names of which they are sometimes known: behavioral objectives, instructional objectives, mission objectives, outcomes, intents, etc. (Merrill, 1971, Fig. 2, p. 78).

Duchastel and Merrill (1973) reviewed several studies on performance objectives and came up with a tentative generalization. They found that out of the six classes in Bloom's (1956) taxonomy of educational objectives (knowledge, comprehension, application, analysis, synthesis, and evaluation), the utility of the behavioral objective strategy appeared to be more useful with higher levels of learning tasks which call for analysis, synthesis, and evaluation.

Although a number of studies (e.g., Hartley & Davies, 1976), have failed to support the hypothesis that students who are provided with performance objectives achieve more than students who are unaware of objectives, a sufficient number of investigations have confirmed the hypothesis to allow a cautious but affirmative opinion on the question of the efficacy of behavioral objectives. The conditions under which behavioral objectives can be considered facilitative remain sketchy and cannot be generalized across global populations. An important component of this study therefore was to control for any prevarication in the manner in which performance objectives are defined and operationalized.

Structured Overviews

Generally structured overviews have been grouped into several categories and are sometimes referred to as graphic organizers, mapping, webbing, pyramiding, graphic summaries, or structured overviews (Cassidy, 1989). For purposes of consistency in operationalization, this instructional strategy henceforth will be referred to in this study as structured overviews.

Researchers have found that using structured overviews as part of preinstructional activities can facilitate student learning and retention of instructional materials (Hartley & Davies, 1976) as well as serve as a "blueprint" for constructing meaning (cited in Greenwald, 1988). In studies done by Carr, Snouffer and Thistlewaite (cited in Greenwald, 1988) structured overviews have helped to activate prior knowledge crucial to understanding passages as well as increased incidental learning.

Cassidy (1989) has taken a more contemporary view--one more closely associated with the context in which structured overviews are used in this study. He has defined a structured overview as a cognitive map in which important aspects of a topic, concept, or unit of study are identified and arranged in a visual pattern with appropriate verbal labels. Again, this definition of structured overviews was adopted in order to narrow its definition as well as make it fairly easy to operationalize.

Hartley and Davies (1976) pointed out that a great deal of success attributed to structured overviews is thought to lie in their ability to emphasize salient points as well as to select and condense instructional materials. Overall, however, the results of the studies reviewed showed generally facilitative effects of structured overviews on learning and retention of textual materials.

Many studies (Duchastel & Merrill, 1973; Hartley & Davies, 1976) have been conducted on the effectiveness of these variables, although very few of them have been documented outside the confines of industrialized countries. In fact, of the more than 800 studies accessed from the ERIC Documents database and Dissertation Abstracts International dealing with the subject of one or more preinstructional activities, none was carried out in Sub-Saharan Africa.

Despite technological advances in information dissemination throughout the world, it is clear that printed materials continue to form the bulk of instructional resources used in schools and training environments in developing countries. The rationale for this study was to determine the efficacy of implementing different instructional strategies using printed materials and subsequently evaluating their capability to facilitate learning. This study was carried out in Zimbabwe where, as the case in most developing countries, the principal problems appear to be a rapidly declining quality in educational standards and a poor instructional design infrastructure (Moock & Jamison, 1988). Moock and Jamison (1988) further point out that undesirably low levels of student achievement and performance experienced in sub-Saharan African countries is a direct result of two problems: (a) internal inefficiency, that is, the educational systems in these countries make poor use of available instructional resources; and (b) they lack the resources or adequate financing to improve the present curriculum design infrastructure. In Zimbabwe, both factors are operative. The country also primarily depends on printed instructional materials, particularly textbooks, as the most appropriate media for improving the quality of instruction.

In this study, the use of selected preinstructional activities was investigated in Zimbabwe's preservice education corps. Using two achievement tests with different performance domains, the study investigated the treatment effects of the following preinstructional activities: 1.) advance organizers; 2.) performance objectives; and 3.) structured overviews. The data gathering instruments were therefore designed to measure maximum performance.

The specific hypothesis tested in this study was:

There would be significant differences between the population means of posttest scores between the traditional approach or control group (CO) and each of the preinstructional strategies, namely, performance objectives (PO), advance organizers (AO), and structured overviews (SO). The rationale behind this was that each treatment variable was expected to enhance recall and learning of specific facts and concepts as they pertainedto the lessons by both focusing the learning effort on relevant information and detracting attention from incidental material. Through the process of orienting the learners to what they would have to know, it was expected that they would be better prepared in learning the most important and relevant parts of the lessons prior to taking the posttest.

Participants

A total of 674 students in their first year of training at the Gweru (n=340) and Bulawayo-Hillside Teacher's Training Colleges (n=334) in Zimbabwe participated in this study. Of these, 408 were males, 193 females. The average age of the participants was 19 and 73 students failed to specify their gender. It must be pointed out that at both locations, participant mortality in the second reading passage was considerable due to the fact that some subjects conceded familiarity with the subject matter.

The two colleges were selected because of the fact that they are the premier preservice teacher training institutions in Zimbabwe. Between them, they represent approximately 60% of the annual pool of preservice teachers who are trained to teach in Zimbabwe's secondary schools. They are also strategically located to geographically cover the northern as well as southern regions which divide the country's two indigenous tribes, the Shona and Ndebele. Through government records, the two institutions were predetermined to have the most representative student body in the country. Geographical, tribal, and gender representation was enhanced by a government fiat which stipulates an admission policy based on regional quotas for both colleges.

All participants were first year trainees who had been admitted after having passed Advanced Level secondary school with a first class or high level second class. Their classification would be equivalent to college freshman in the United States while their entry level grades would represent A or B-plus respectively. The training for all participants was structured to be inclusive of arts and science subjects.

To increase power and precision, this study sought the participation of the whole student population from both colleges. As a matter of national pride and duty, all subjects were asked to volunteer their time in participating in the study as the results were to impact on the designing and development of Zimbabwe's post-independence curricula. In all, participants represented approximately 80% of the freshman student population for both colleges.

Experimental Design

The independent variables in this study were defined as advance organizers, performance objectives, and structured overviews. These have been defined in the introductory chapter of this study.

Four levels of treatment variables were used: control (CO), structured overview (SO), advance organizer (AO), and performance objectives (PO). The three treatment variables (structured overview, advance organizer, and performance objectives) were studied in isolation from one another. The outcome of each variable was expected to reflect its contribution to the study.

Student participants at the two colleges were randomly assigned to one of the four treatment conditions by randomly ordering each of the self-contained instructional materials. In classes that averaged roughly 100 participants per session, a random-ordering system that involves randomly ordering and marking each of the four types of instruction, say 1, 2, 3, and 4, and distributing them was used.

In addition, all modules representing different treatment conditions were color coded. After random assignment of the treatment conditions, participants were assigned to four sections of the room each representing their module by color. Student participants at each location were asked if they were familiar with the selected reading passages before they began with the exercise. Those who had any prior knowledge of the narratives were dropped from the sample. Participants were also asked to record the time they started and finished both the reading module and the posttest. Each student was given 45 minutes to read a passage, and a fifteen-minute posttest followed immediately. This process was repeated with the delivery of the second set of the written modules and posttest.

The achievement measures were recall and conceptual learning as determined by the administration of two immediate posttests. A simple one-way analysis of variance (ANOVA) design was utilized to analyze the data.

A technique proposed by Glass (1978) by which treatment effects may be quantified, standardized, and compared using the "effect size" statistic (E.S.) was also used. The rationale behind this was to examine all effect sizes, regardless of magnitude, and the degree to which they were worthy in their own right.

Materials

In this study, two reading passages unfamiliar to the participants were selected and developed. The rationale behind using two instruments was to determine whether uniform results could be found after applying both instruments to participants within the same population. An additional reason for using two lessons with two achievement tests was to increase the power and precision of the overall instrument.

The content of both instructional materials covered technical and nontechnical subjects so as to be inclusive of the participants academic background, which was science and humanities. The first reading passage, amounting to approximately 800 words, was adapted from a textbook on still photography (Grimm, 1985). The passage had technical language that dealt with the basic operational functions of the 35 millimeter single lens reflex camera. The title of the passage was The Basic 35 Millimeter Camera.

Refinement of the reading passage included eliminating any parts of the text that were deemed superfluous and potentially distorting or confusing to the participants. All sectional headings, subtitles, pull quotes or any other attention getting devices were removed in order to avoid any interactions with the treatment variables.

The readability of the text was verified using a computer program to ensure it was at the Zimbabwe Grade 7 (U.S. 8th grade) level and thus, presumably below the participants maximum reading level. The reading materials were timed for reading length to ensure that they would be of appropriate length given the permissible time allocated to the researcher. The second reading passage, amounting to approximately 750 words, was adapted from a book featuring timed readings (Spargo & Williston, 1980). The selected passage dealt with the topic of American bald eagles. This passage, entitled The Bald Eagle, was less technical in presentation, substance and style than the first passage. Materials were developed by the researcher into a reading text by combining information from subject matter experts in the area dealing with the American bald eagle.

In order to avoid any interactions with the treatment variables, the same refinement procedure used for the first reading passage was applied to the second lesson. The reading materials were also timed for reading length and readability level.

Because the first reading passage was more technical and somewhat more complex than the second one, an item analysis on the post-tests of both passages was conducted. This was to indicate the percentage of participants who correctly answered each item on both test components.

The text materials were formatively evaluated to determine whether indeed, they were appropriate. Editorial advice was sought from a group of instructional design experts, two English Professors, and two high school students. This process was designed to ascertain the logical flow of ideas contained in the instruments.

A second formative evaluation for both reading passages was carried out in Zimbabwe under circumstances closely resembling the actual experimental conditions using teachers from a teacher's college in Harare. The initial developmental strategies were applied to conform to the original intention of the study.

For each reading passage, an advance organizer, a set of performance objectives, and a structured overview to be used as treatment variables were developed with the help of the same panel of experts who assisted in developing the reading passages and test items. Each intervention was formatively evaluated to maintain consistency between the lesson content and ideas from the treatment variables. Special consideration was given to layout so as not to confound the target learners. All the treatment variables were printed in such a way as to be distinct from the reading passage.

The two achievement tests accompanying the reading passages were designed to measure two levels of skills: a) recall of information, and b) knowledge of concrete concepts. A list of items was drawn from each reading passage to represent the desired performance domain. Test items were divided into performance categories of verbal information and concrete concepts, the latter being a subcategory of intellectual skills (Gagne´ et al., 1988).

Validity and Reliability

To obtain a performance indicator that verbal information had been acquired, participants were asked to state in writing different pieces of information related to the passages. As a performance indicator that concrete concepts had been acquired, participants identified objects by their properties or classes, and animals by their species or special characteristics.

All verbal information was organized and presented in statements which were comprised mostly of facts or declarative information. Concrete concepts were presented by widely varying their characteristics so that each individual participant was asked to identify by circling, choosing or checking from a group. Concepts such as species or types of mechanical devices were identified in this manner as well.

A uniform procedure was used on both achievement tests to establish content-related validity. This procedure involved developing the tests based on a set of performance objectives (Mager, 1962).

In order for student performance to be legitimately represented by a single score, each achievement test or subtest had to measure a single learning domain pertinent to each given written instruction. Each achievement test used in this study was checked for internal consistency using the Kuder-Richardson or KR-20 formula.

Procedures

The strategy for administering the instruments was for the researcher to travel to the different teachers' colleges at which he administered the treatment and instruments with the assistance of members of staff at the two colleges. All participants were advised of the relevance of the study and its implications regarding the development of Zimbabwe.

They were also advised of the implications of the study from the point of view of an instructional design and materials development.

Analysis of the Data

This study design involved administering two achievement tests to respondents. Participants in the first achievement test exercise were comprised of 470 first year preservice teachers from Gweru and Bulawayo-Hillside Teacher's colleges. This group was referred to as the 35mm SLR group. Participants in the second exercise were comprised of 204 first year preservice teachers from the same teachers' colleges. This group was referred to as the Bald Eagle group. The dependent measures for this study were recall and conceptual learning as determined by total posttest scores.

The results of the data analysis are presented in the following order: posttest performance on the two achievement tests, the 35mm SLR post-test and the Bald Eagle post-test. The Kuder-Richardson reliability coefficient alpha for the two sets of achievement tests data are shown in Table 1.

Table 1

Posttest Reliabilities: Kuder-Richardson (KR-20) Reliability Coefficient For the 35mm SLR and Bald Eagle Post-tests

Test Group	N	KR-20 Reliability
35mm SLR	470	.585
Bald Eagle	204	.627

The cell means, standard deviations and relative performance of the four groups are presented in Table 2.

Table 2

Means and Standard Deviations by Treatment Group of the 35mm SLR Group

Treatment Groups	n	Mean	E.S.	SD	S.E. ERROR
CO	109	13.670	-	2.506	.240
AO	119	13.899	.09	2.506	.230
SO	120	14.150	.19	7.430	.678
PO	122	14.008	.13	2.710	.245
Total	470	13.938		4.354	.201

Note: Maximum score is 18 for the posttest.

A one-way ANOVA was also computed for the first posttest. Based on the performances of each group, the differences between groups on the 35mm SLR post-test were not statistically significant. Since there was no significant univariate effect at alpha .05, any further analysis could not be warranted.

The results of participants in the Bald Eagle group are summarized in Table 3. Table 3 also shows the relative performances of the treatment groups, including the basic sample statistics.

Table 3

Means and Standard Deviations by Treatment Group of the Bold Eagle Group

Treatment Groups	n	Mean	SD	E.S.	Std.Error
CO	53	13.627	2.154	-	.302
AO	50	13.660	2.269	.01	.324
SO	52	14.980	2.661	.51	.376
PO	49	15.208	2.103	.75	.303
Total	204	14.359	2.405		.171

Note: Maximum score is 18 for the posttest.

A one-way ANOVA was computed on the Eagle posttest. Based on the performances of each group, the differences between the control group and the performance objective group were found to be statistically significant. The ANOVA also detected significant differences $F(.05; 3, 200)$, $p<.05$ between the control group and the structured overview group. There was no significant difference between the control and the advance organizer group.

A major problem in the technique used to analyze the data so far is that it does not take into account any positive treatment effect that fails to reach statistical significance. Hence studies showing positive, yet statistically non-significant effects are given no further analytical consideration. Such results may be biased against favorable yet non-significant results.

A technique proposed by Glass (1978) by which treatment effects may be quantified, standardized, and compared using the "effect size" statistic (ES), was found appropriate for this study. It is important to note here that the intention of using this effect size approach was not to test statistical significance of the effect size, but rather to offer an alternative in looking at group differences. It is also equally important to note that use of Glass's Effect Size technique was not to suggest any negation of non-significant outcomes from Analyses of Variance conducted in this study.

The effect size data for the 35mm SLR and the Bald Eagle groups post-tests are shown in Tables 2 and 3 respectively. Effect Size data appear to suggest that the treatment variables used in this study have a facilitative effect on learner recall and conceptual learning in varying degrees and magnitude.

In looking at data from the 35mm SLR group, the effect size range is from .09 to .19 suggesting a somewhat less than useful treatment effect in as far as the advance organizer is concerned. The effect of the advance organizer in this instance was of no practical importance. In looking at the effects of the performance objectives and the structured overviews groups, the difference between these two groups when compared with the advance organizer group, while larger, is still negligible.

Table 3 effect size indices appear to present a somewhat different composite picture. While the effect of the advance organizer remains of no practical importance, the performance objectives and structured overviews groups appear to have moderately useful to sizable effects on learner recall and conceptual understanding. In looking at both achievement tests, the trends in the data seem to be fairly consistent. Results seem to indicate that the advance organizer was the least effective preinstructional activity when compared with performance objectives and the structured overview.

Discussion

In general, the findings in this study appear to be consistent with those of previous research (Duchastel & Merrill, 1985; Barnes & Clawson, 1975; Gagne´ et al., 1988). These results seem to indicate that performance objectives may have the most beneficial effect.

Despite the small differences in the means between groups in the first achievement test, the trends in the data, when compared with the second achievement test, seem to be fairly consistent. In both achievement tests, performance objectives come out relatively superior to any of the other treatment variables. Structured overviews appear to rank second, followed by advanced organizers.

With respect to the overall framework of the study, several issues appear to require some explanation. There remains the question of why the differences between the treatment groups in the 35mm SLR group were not statistically significant while significant differences were detected between groups in the Bald Eagle group.

An initial explanation may be found in the differences in content between the two passages. The 35mm SLR reading passage was relatively more technical than the the Bald Eagle passage. In conducting an item analysis on both test components, item difficulty, as indicated by the percentage of students who correctly answered each test item, was much higher in the the 35mm SLR group passage than the the Bald Eagle group passage. The average item difficulty index for the 35mm SLR group was .70, while the item difficulty index for the Bald Eagle group averaged .76.

Another observation here is, by design, advance organizers are fairly complex to describe and interpret, and hence they are likely to be inconsistent in terms of how effective they may be. The impact of the advance organizer as it is designed in this study may have had been more pronounced on higher level learning than simple factual recall. Simply committing facts to memory may be a less demanding process than understanding material to the point where learners are expected to answer questions that draw on information not explicitly contained in the material to be learned. Since the advance organizer is supposed to facilitate comprehension, and the structuring together of old and new information, it is likely to have more impact on higher level learning than on factual recall and recognition.

By comparison, the performance objectives and structured overviews leading to both reading passages in this study provided specific information derived directly from the content of each lesson. Both of these preinstructional strategies provided precise and unambiguous information upon which the learner was expected to focus.

In the context of a developing country such as Zimbabwe, data from the two achievement tests administered to preservice teachers appear to support the use of preinstructional activities in the design and development of lessons. Central to this discussion is the fact that traditionally, the teacher within the Zimbabwean educational context has always been viewed as supreme within a pedagogical environment. Instructional materials such as textbooks, media, and other support resources, are secondary. The instructor's use of any of these support systems is discretionary, not mandatory. Coming at a time when the government of Zimbabwe is trying to remove the vestiges of colonialism from its curricula, these findings may be somewhat important.

The findings of this research also seem to suggest that stated preinstructional activities may have a global pedagogic value. Furthermore, it is important to note that this study may be one of very few ever done outside the United States and Western countries in general.

While overall the present findings provide limited support for the types of preinstructional strategies investigated in this study, it is important to note that these results do not depart from pervious research on the same topic. For example, in the experimental phase of this study, the effect of performance objectives appears to be consistent with results from previous studies (Barnes & Clawson, 1975; Duchastel & Merrill, 1973). This may suggest that the effective and efficient use of preinstructional activities traverses cultures and international boundaries.

While it may be useful to determine the practical significance of the use of preinstructional activities, future studies may also find it equally important to consider the costs of using such innovations. Evidence of effectiveness may then be tied to guidelines and/or standards in ways that deal more realistically with the present emphasis on efficiency and accountability for the use of scarce public and private financial resources. Better understanding of the instructional systems design approach should be encouraged, as it is a method which has already proven useful in demonstrating effective instruction.

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Title:

Window Presentation Styles And User's Spatial Ability

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ABSTRACT

The purpose of this study was to examine the effects of spatial ability level and window presentation style of tiled and overlapped computer displays on the achievement of dental hygiene students.

All forty-three first-term Dental Hygiene students enrolled full-time at a University School of Dental Medicine were the sample who participated in this investigation. Phase one of this project consisted of administering the Differential Aptitude Test: Space Relations Subtest to assess each subject's spatial ability. Individuals' scores were examined using a frequency distribution. Participants who ranked greater than the median were classified as having high spatial ability. Scores less than the median were categorized as the low spatial ability group.

Two HyperCard Stacks were produced targeting the topic of *Ergonomics in Dentistry*. The stacks were designed with identical content and differed by displaying the information in one of the two window presentation styles. Subjects were randomly assigned by spatial ability level to one of two treatment groups: tiled or overlapping displays. During phase two, each subject executed the corresponding computer-based tutorial program and completed an identical module test. A 2 X 2 analysis of variance (ANOVA) was used to analyze the achievement scores. A disordinal interaction in terms of achievement between the two factors was identified with significance at the .01 level.

BACKGROUND

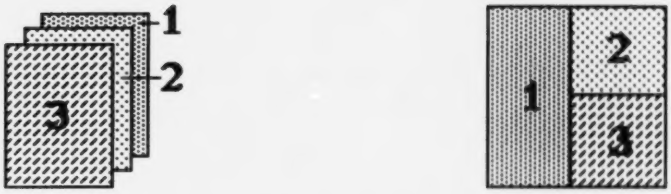
Despite limited theoretical and empirical research to justify their usage, windowing environments are widely used as primary computer interfaces. The visual display mechanism of a window environment appears to capitalize on the spatial organization of the computer screen. Windows subdivide the computer screen into distinct sections each containing different bits of information. The information contained in the windows can be viewed simultaneously using tiled displays or in segments via overlapping techniques.

> "Windowing systems, according to their proponents, are inherently easy to use and automatically conducive to user productivity. But, while it is clear that some windowing systems offer benefits to some users under some conditions, we still have little understanding of the implementation, user, and task parameter that lead to increased productivity and satisfaction" (Billingsley, 1988, p. 413).

Since their inception in the early 1970's, windows have been *assumed* to be useful based on user feedback and personal preference indicators (Miller & McMillan, 1984). To date, however, little research has been conducted on the effects of the use of the various windowing techniques (Jonassen, 1989, Marshall, 1986, Bly & Rosenberg, 1986, Cohen, 1985, and Bury, Davies, & Darnell, 1985). Therefore, careful examination of the desktop screen design may be an essential component for window utilization.

Windows are commonly employed in computer-based educational programs to display information using the same or different data, to access peripheral program, and to provide links to other multimedia workstations. Two common types of windows are defined by their placement on the screen. The first window configuration is termed "overlapped" i.e. one window obscuring another. Overlapped or stacked windowing displays simulate a realistic desktop with sheets of layered paper. In an overlapping window environment, the learner is only permitted to view a section of the window because the windows are overlaying one another producing a stacked effect. An overlapping window system requires a learner to utilize his/her visual skills in a three-dimensional arena.

The second window display, referred to as "tiled" i.e. windows not obscured by one another. In a tiled display, one can view each window on the display screen without any obstruction from each of the other windows (Miller & McMillan, 1984 and Jonassen, 1989). Tiled window screens display information to users so that they may view the windows simultaneously. In a tiled window system the learner draws on his visual abilities by interacting with the program in two-dimensional space. See Figure 1 for the visual representations of overlapping and tiled window systems.



Overlapping Window System **Tiled Window System**

Figure 1. Window Systems

Limitations in human memory are fundamentally important considerations with regard to cognitive performance of any task including the manipulation of a window system. Tiled and overlapped window configurations serve as external memory devices to the user's internal memory, therefore extending the participant's internal memory capability. Windows tend to alleviate, in part, the memory load of the learner by serving as "markers" of unfinished tasks as well as enabling individuals to view more than one data set at a time. (Billingsley, 1988 and Card, Pavel, & Farrell, 1984). A dilemma may occur with the learner's new found "cognitive freedoms". New cognitive strategies and encoding requirements may need to be developed by the learner when in the windowing environment, a condition which may already be cognitively overloading to the user (Sullivan & Stephen, 1985). Researchers have attempted to compensate for the potential memory load dilemma by choosing window environments that depict true world experiences as well as by providing practice to the user within the windowing display.

Windows appear to serve as *tools* for learners which makes it possible for them to hold information in memory, organize, and retrieve it. Documented research does not clearly explain how this tool functions as a memory device. However, researchers do suggest that this storage structure for visual information should be compatible with human perception, retention, comprehension, and retrieval processes (Reilly & Roach, 1986). A global presentation of the information is afforded by the tiled displays. Tiled configurations permit the user to divide the display into small chunks of information, view several bits of information simultaneously, organize it, and hold the data in working memory. "A tiling system makes it easy for users to keep track of all open windows by visually inspecting the display..." (Billingsley, 1988, p. 420).

Overlapped displays require active participation of the user's ability to hold information in the working memory from one display to another and spatially relate the data. In this case, the windows serve as data reminders or "markers". The user must be able to infer that information is present even though it is covered by another window (Norman, Weldon, & Shneiderman 1986). An overlapping system makes it possible to 'lose' or forget about windows that are covered by other windows (Bury et al., 1985). Learners must be spatially astute when using the overlapped screen design.

Jonassen (1989) has identified six major purposes of windows including operational qualities, navigational functions, organizational/explicative modalities, explanatory/help factors, metaphorical operations and exploratory devices. To date, little empirical and theoretical research has been conducted on the effects of the use of the various windowing techniques (Jonassen, 1989, Marshall, 1986, Bly & Rosenberg, 1986, and Bury et al., 1985). Therefore, the need for experimental research in this area is necessary for the improvement of current and future computer-based instructional packages.

Miller and McMillan (1984) infer that tiling and overlapping window choices are "basically a matter of personal preference" rather than based on specific cognitive strategies or skills (p. 98). This theory has been challenged in the proposed research project. It was postulated that performance would be enhanced when selective matching occurs between level of spatial ability and windowing style. It was hypothesized that individuals who demonstrate high spatial ability would perform better when using overlapped windowing environments. In contrast, low spatial ability learners were expected to have better educational outcomes when using tiled windowing displays.

Norman et al. (1986) express a similar thought: "When there is a mismatch between the user's visual expectations about the pattern of the display and the actual operation of the system, it is hypothesized that performance will be impaired. On the other hand, if multiple windows and coordinated screens are used in a manner that supports the user's expectations, they will become powerful tools for creating new work environments and increasing the visual scope of the user" (p. 231). The authors have suggested that the learner's spatial ability must be considered when designing and using window screen designs in computer-based instructional programs.

By using windows, data no longer is solely represented in two-dimensions via tiled displays; but rather three-dimensionality is introduced using overlapped techniques. These technological changes require that learner factors, especially spatial ability level should be considered in computer-based program design. To date, documented research regarding the effects that spatial ability may have on performance outcomes has not been adequately addressed when windowing presentation styles are developed to display computer program data.

Primary mental abilities such as spatial ability are "cognitive skills that enable individuals to learn, think, and reason" as stated by Thurstone (1938) cited in Jonassen and Grabowski (1993, p. 63). Jonassen and Grabowski (1993) add to this definition by stating that spatial qualities include the use of: "...visual skills, spatial manipulation, similarity of visuals, and imagining how visuals might appear in other orientations" (p. 64). Bishop (1980) has identified two categorical demarcations for spatial ability which make a distinction between "low-level spatial abilities, which require visualization of two-dimensional configurations but no mental transformations of those visual images, and high-level spatial abilities, which require visualization of three-dimensional configurations and the mental manipulation of these images" (cited in Cohen, 1985, p. 29). The definition of spatial ability in this study was drawn from Bishop's second category and defines spatial ability as both the visualization and manipulation of objects (windows) in space.

Learners possess a wide range of spatial ability levels. Continuing research has investigated differences in spatial knowledge: how individuals acquire, manipulate, encode, and retrieve information (Thorndyke, 1980). Highly spatial individuals possess the aptitude to remain unconfused by the changing orientation in which the spatial configuration may be presented (McGee, 1979). Spatially astute subjects tend to use visualization strategies more effectively, therefore, exhibiting better visualization abilities. Educators may overlook the learner's spatial ability and the differences among learners' abilities when designing instructional materials. Computer program developers may also be ignoring this mental ability when creating computer-based packages.

Windows, one type of graphical user interface, call upon user's spatial ability to a high degree. Tiled displays represent data in two-dimensional space whereas overlapping environments depict information in three-dimensional space. Billingsley (1988) comments on window presentation style by adding that: "This attribute specifies the possible spatial relationships between windows and, to some degree, the types of operations that can be performed on them" (p. 419).

If spatial ability levels interact with the screen designs and memory requirements of the tiled and overlapping window environments, then one should consider the spatial ability of the learner when selecting appropriate screen displays for computer-based instructional packages. The purpose of this study was to investigate the interaction between spatial ability and window presentation styles (tiled, overlapping).

METHOD

This study followed the format of Aptitude-Treatment-Interaction research in that the aptitude of learner spatial ability was contrasted with two window presentation formats. The research design employed in this study is depicted in Figure 2.

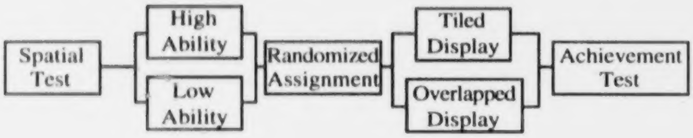


Figure 2. Research Design

The research sample was comprised of all forty-three, first-term Dental Hygiene students who were enrolled full-time at a University School of Dental Medicine Dental Hygiene Program. All subjects were volunteers for this study and represented 100% participation of the Dental Hygiene class. Forty-one subjects (95.3%) were female and two (4.7%)

were male. The majority of the subjects were 18-25 years of age, had a variety of educational backgrounds and computer proficiency levels.

The Differential Aptitude Test: Space Relations Subtest was administered to all Dental Hygiene students. Students were dichotomized into high and low spatial ability groups using the median score, 26.8, as the "cut off" point. Students scoring above the median were defined as high spatial ability and those scoring below the median were categorized as low spatial ability. Students from each group were randomly assigned to one of two treatment groups, tiled or overlapped, using stratified random assignment procedures.

Two HyperCard Stacks were produced by the author targeting the topic of *Ergonomics in Dentistry*. The tutorial stacks were designed with identical content and only differed by displaying the information in one of the two presentation styles, tiled or overlapped displays. Information was presented using various forms such as text, audio, digitized voice responses, diagrams, figures and realistic digitized images.

At the completion of the assigned computer-based treatment, an achievement examination consisting of 31 questions assessing subjects' knowledge of the content presented in the program was administered to all subjects. The completion of all parts of this study took each subject approximately one hour.

RESULTS

A 2 X 2 ANOVA was used to analyze the research results. Spatial ability and window presentation styles were the two factors.

The means and standard deviations of the achievement scores by spatial ability and type of window presentation style are presented in Table 1. As can been seen from the table, the size of the four research groups ranged from 10 to 12 subjects. The total possible score that could have been attained on the achievement test was 31.

The Statistical Package for the Social Sciences (SPSS) Version 5.0 was used to analyze the data. Table 2 displays the ANOVA summary for the achievement scores. The interaction between spatial ability level and window presentation style produced an F value of 7.53 which was significant at the .01 level. The resulting disordinal interaction is plotted in Figure 3. Since a significant interaction was obtained, examination of main effects were not appropriate. The plot indicates that subjects who were identified as having high spatial ability performed significantly better in the overlapped window environment. Conversely, low spatial ability subjects scored significantly higher using the tiled displays.

Table 1

Means and Standard Deviations of Achievement Scores by Spatial Ability and Type of Window Presentation Style

	Presentation Style					
	Tiled			Overlapped		
Spatial Ability	n	M	SD	n	M	SD
High	11	22.73	1.79	12	24.42	1.93
Low	10	24.30	2.50	10	22.20	2.78

65

Table 2

ANOVA Summary Table for Achievement Scores

Source	df	MS	F	p value
Spatial Ability (A)	1	1.11	0.22	0.64
Presentation Style (B)	1	0.45	0.09	0.77
A X B	1	38.37	7.53	0.01
Error	39	5.10		

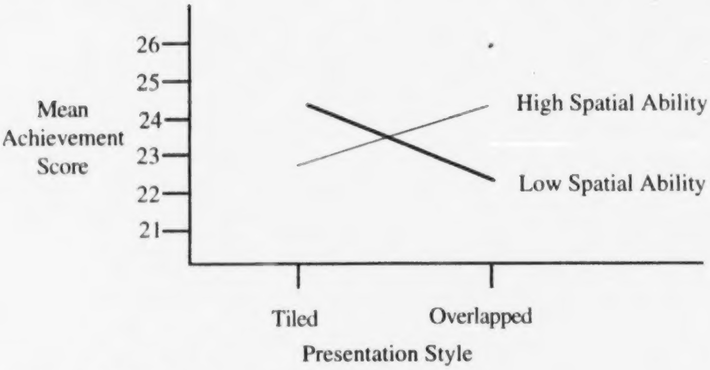


Figure 3. Interaction of Level of Spatial Ability and Presentation Style

DISCUSSION

The tiled and overlapping windowing environments appear to have served as external memory devices to the user's internal memory source, thereby extending the participant's internal memory capability as predicted by Billingsley (1988) and Card et al. (1984). Windows appear to alleviate, in part, the memory load of the learner by serving as "markers" of unfinished tasks via overlapping displays or by enabling individuals to view more than one data set at a time through tiled displays.

In this study, subjects who demonstrated higher spatial skills obtained greater educational outcomes from the organization of the overlapped window formats. This may be in part due to the cognitive organization ability of the highly spatial individuals who were able to mentally hold and relate the data. The overlapped windowing system permitted the highly spatial learners to "mark" data and employ their three-dimensional visualization skills. The overlapped displays required users to hold information in working memory from one display to another and to spatially relate the material.

Conversely, tiled displays enabled low spatial ability subjects to perform better when viewing information that was presented side by side in a two-dimensional configuration via the tiled windowing environment. Tiled configurations permitted the user to fully view several bits of information simultaneously and hold the data in the internal memory source. Since individuals with low spatial ability have limited visualization skills, these subjects were better able to remember tiled program data because the information was displayed with open windows permitting full visual inspection of the screen displays. The low spatial ability group was not required to mentally manipulate and relate the data, as in a overlapped windowing system. The tiled display appears to better complement the low visualization ability of the low spatial ability learner group. When window formats were properly matched to the learner's spatial capability more successful educational outcomes where obtained.

It is interesting to note that students exhibiting high spatial abilities performed poorly when using tiled windows. The reason for this finding is not clear. However, it may be concluded that these learners prefer to impose their own spatial schemata on the information presented and do not perform well when an incompatible, program defined schema such as presented in the tiled treatment is imposed on them. Further research is clearly needed to investigate this issue.

The disordinal interaction found in this study strongly suggests that the factor of user spatial ability has significant implications for the types of window formats which will be most beneficial. Clearly, those students with high spatial skills did profit most from the perceptually more complex overlapped environments, while those with low spatial abilities needed the more global presentation of information afforded by tiled windows. The cognitive process, spatial ability, appears to be one of the factors that needs to be considered when selecting computer-based instructional packages that exhibit windowing systems. Compatibility of the learner's spatial ability level with the appropriate window environment has been shown to benefit the educational outcomes. Therefore, additional research studies paralleling and extending the current project are recommended.

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Title:

Reflections on the Interface Design of The Perseus Project

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The Perseus Project is an undertaking begun in the Classics Department of Harvard University. It is devoted to the creation of a massive interactive hypermedia product, called "Perseus," on ancient Greek culture. According to Crane and Mylonas in their 1988 article: "The Perseus Project is developing interactive, computer-based materials on Greek Civilization. These are designed to support learners, instructors, and researchers as they explore this complex subject" (p. 25). "Perseus' main audience consists of students who are classics or archaeology majors or who are taking a course in classical civilization, and of graduate students or scholars in these fields" (Mylonas, 1992).

Perseus is in the tradition of and builds on the ideas and earlier hypertext projects of such visionaries as Vannevar Bush, Douglas Engelbart, and Theodor Nelson. The huge storage requirements of Perseus were anticipated by Bush (1945) in his seminal article "As We May Think" in Atlantic Monthly. The basic ideas of hypertext systems were expounded by Engelbart in his 1963 article entitled "A Conceptual Framework for the Augmentation of Man's Intellect." His NLS and Augment hypertext systems emphasized three ideas: "a database of nonlinear text, *view filters* which selected information from this database, and *views* which structured the display of this information for the terminal" (Conklin, 1987, p. 22). Nelson's Xanadu hypertext system hoped to incorporate all the world's literary efforts. Nelson claimed that "The evolving corpus is continually expandable without fundamental change. New links and windows can continuously add new access pathways to old material" (as cited in Conklin, 1980, p. 23).

Unlike many of its predecessors, the Perseus Project is serious attempt to move an extremely large hypertext database from theory into practice. In contrast to Xanadu, Perseus concentrates on a single subject limited by geography and time. Brown University's Intermedia delivery system, which is an outgrowth of Nelson's work, was considered for Perseus, but rejected since it could only run on expensive workstations which cost $7000 to $10,000 each (Hughes, 1988). Apple's HyperCard, introduced in 1987, appeared just in time to be adopted as the delivery system for Perseus.

Why is the Perseus Project Important?

If the goal of creating a huge database on ancient Greek culture were the only thing riding on the success or failure of the Perseus Project, then the work on this esoteric project would receive coverage in journals on the classics, but be little more than a footnote in the history of hypertext and hypermedia software. However, the potential implications of Perseus extend far beyond the study of Greek history. The literature about hypermedia and hypertext includes frequent references to the Perseus Project. In journal articles, it is commended as a model for hypermedia development. Hughes called the Perseus Project "today's most ambitious, intriguing, and promising application of computer technology to academic instruction and research in the liberal arts" (1988, p. 1). In her article about evaluating Perseus, Neuman said: "The project is innovative in its development process, its technological sophistication, its range of potential applications, and its intended outcomes" (1991, p. 239).

Gregory Crane, the Editor-in-Chief of the Perseus Project, and Elli Mylonas, Managing Editor, claimed in their 1988 article that they "are committed to making Perseus useful in as many different academic environments as possible" (p. 26). Further, they expect that "a working model of electronic publication will exert influence far beyond the realm of classical studies" (p. 26) and that they will "provide a blueprint which others can initially and subsequently improve" (p. 26).

In his article "Redefining the Book: Some Preliminary Problems" (1988b), Crane speculated that the Perseus working model might substitute for or replace traditional means of publication. Crane and Mylonas (1988) predicted that once the material is gathered, Perseus 5.0 and subsequent editions could be produced at a cost no greater than printed books. The Perseus Project was committed to producing the core data and software at a price equivalent to the cost of a regular required textbook (approximately $40 in 1988) so that it would available to individual students.

What Is the Perseus Project?

The Perseus Project is known in the literature as an interactive hypermedia product, but it is also a name used for the entire enterprise which created the product and continues to support it and plan for its future. The developers tend to call the enterprise "The Perseus Project" and the hypermedia product itself "Perseus." This paper will follow the same convention.

Contents

> [Perseus] will include almost the entire surviving body of Greek Tragedy, comedy and epic; works of major historians such as Herodotus and Thucydides; and substantial portions of the massive surviving works of Plato and Aristotle. There will be color images and measured drawings of museum objects (such as sculpture and Greek vase paintings), plans and pictures of buildings and sites in Greece, and an atlas based on Landsat images. Much of the material commonly studied in courses on classical Greece will be included in the database. (Crane, 1988a, p. 51)

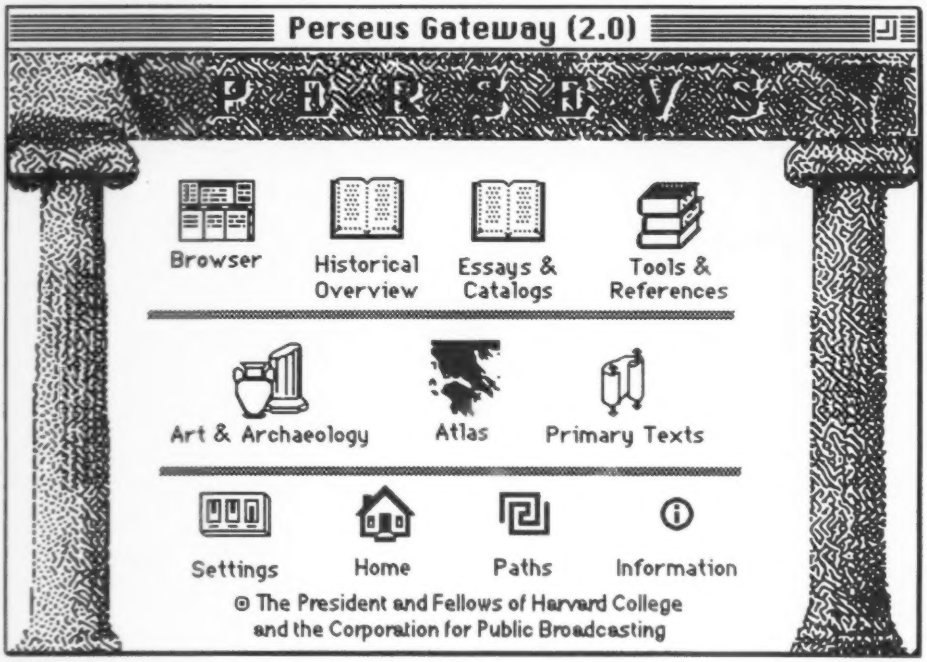

Figure 1. The Perseus Gateway

Funding

The first funding proposal for Perseus was made to the Annenberg/CPB Project in January 1986 by G. Crane, R. Grant, V.J. Harward, A. Henrichs, T. Martin, G. Nash, and D.N. Smith. Hughes (1988) claims that the funding proposal to the Annenberg/CPB Project, Apple Computer, and Harvard University dated May 24, 1988 which covered funding from January 1989 to December 1992 is for $3,390,541. "When completed, Perseus will have cost between $4 and $5 million" (Hughes, 1988, p. 3). Crane (1990) confirmed a figure of "approximately $3 million between 1987 and 1993" (p. 35). Crane and Mylonas (1988) hoped that Perseus would "become an ongoing concern and can retain its vitality long after major external funding has ceased" (p. 26).

Development

The content of Perseus was the work of a team of classicists and other specialists at Harvard and Boston Universities, and Bowdoin, Pomona, and St. Olaf Colleges. Each classicist was responsible for developing one or more of the topic areas (Crane and Mylonas, 1988). According to A.M. Lewis, a Perseus Project staff member at Harvard University, "The programming was done by several people, including Sebastian Heath, Neel Smith, and our current programmer, Jake Sisk" (e-mail communication, November 18, 1993). The instructional design process included "our Editor-in-Chief, Greg Crane, the programmers mentioned above, and many other people" (A.M. Lewis, e-mail communication, November 18, 1993). Kate Withey of Willow Design has been given credit for the "user interface to Perseus" (Crane, 1992a). Lewis gives credit for the "general shape" and "very existence" of Perseus to Crane. In fact, Lewis claimed that Crane chose the Perseus name when "Odysseus" was ruled out for having too many syllables and starting with a vowel (e-mail communication, November 22, 1993). There was no instructional designer.

Delivery System

Perseus 1.0 will run on a Macintosh LC with a hard drive. Either a CD-ROM drive is needed or a file server on a network which is able to access the CD-ROM on which Perseus is stored. A videodisc player and monitor is needed if the videodisc is to be used. The videodisc has full motion and still frame video with "short introductions to three major sanctuaries of ancient Greece: Delphi, Eleusis, and Olympia. These sequences can be played as continuous video, with a voice-over commentary on the history and archaeology of the sites" (Crane, 1992b). Still images in Perseus appear on both the CD-ROM and the videodisc.

Perseus 2.0 will be published in two editions, the Comprehensive Edition on a four CD-ROM set and the Concise Edition on a single CD-ROM.

Future Releases

The plans in 1988 called for cumulative releases of Perseus 2.0, 3.0, and 4.0 for the fall of 1990, 1991, and 1992, respectively. "Perseus 4.0 will contain between forty and one hundred megabytes of textual information (approximately forty to one hundred volumes of text, or between five and ten percent of the surviving literary material) and several thousand images" (Crane and Mylonas, 1988, p. 26). Perseus 5.0 was scheduled to be released in December, 1993 (Crane, 1990).

The User's Manual for the beta version of Perseus 2.0 announced that this version of Perseus "represents the completion of a plan, first outlined in 1985, to construct a large and heterogeneous database of materials — textual and visual — illustrating the Archaic and Classical Greek world." The future directions for the Perseus Project include producing a version of Perseus for Windows and continuing to improve Perseus site on the World Wide Web (http://www.perseus.tufts.edu). The Perseus Project followed Crane to Tufts University in 1993.

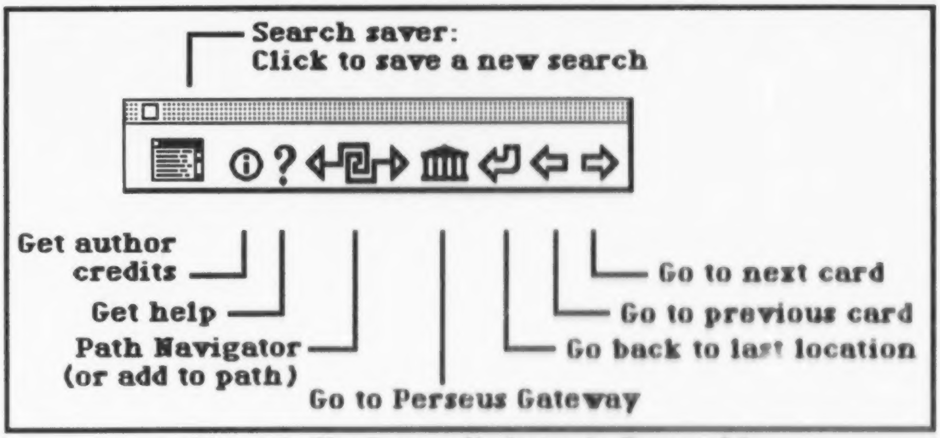

Figure 2. The Perseus Navigator in Perseus 2.0

Costs

In 1993, the entire Perseus package cost $350 ($200 for the videodisc and videodisc index, $125 for the CD-ROM, and $25 for the user's guide) according to the Perseus Order Form available from Yale University Press (YUP). The predicted price for the Comprehensive version of Perseus 2.0 with four CD-ROM set and possibly a videodisc was about $500 (e-mail communication, December 17, 1995). As recently as 1993, Crane was still hoping to move from sales to institutions to sales to individuals where the price of Perseus would be kept below $50 (Crane, e-mail communication, November 20, 1993). However, there are currently no plans to make that vision a reality.

Acceptance

The initial positive reaction to Perseus in the late 1980s in the general literature about hypertext and hypermedia was no doubt aided by descriptions of special features in Perseus. Crane and Mylonas (1988) claimed that in the first year of work that those involved in the project had "developed exercises that help the learner focus on important aspects" (p. 27) of the content, that they "used animation to illustrate the progress of a battle and the techniques of architectural drawing" (p. 27), and that they have "employed maps as an introduction to prose history" (p. 27). The Perseus Sampler, which is a pre-Beta prototype of Perseus 1.0 that reviewers like Hughes (1988) actually used to formulate their opinions of Perseus, included these three features.

These three features were all special projects developed in conjunction with the Perseus materials and their descriptions appear in the footnotes of the 1988 Crane and Mylonas article. Figures of sample screens also appear in the aforementioned article. It is surprising that none of these three features appear in Perseus 1.0 since so much space was given over to describing them in the article. Those who read the 1988 article, may have had an opportunity to examine the Perseus Sampler, and did not have a chance to examine Perseus 1.0 might erroneously assume that these three features were an integral part of the commercial release of Perseus and, thus, have an inflated opinion of the capabilities of Perseus.

Writing for the Bryn Mawr Classical Review, Eiteljorg, Hamilton, O'Donnell, Pearcy, and Wiltshire (1992) noted: "The task of Perseus is teaching. Arrangement of information forms part of teaching, but it is not the same as teaching. In order for teaching to happen, one human intelligence must encounter another. A student using Perseus is not likely to come away with a sense that someone has intended that he learn something." Pearcy in particular objected to the non-biased approach to this material. He said "Theirs is a neutral, liberal program allowing unguided links between miscellaneous data … and the decision to avoid prescriptive links between data may be a weakness in Perseus." Although problems with the operation of Perseus were noted and the instructional design decisions were posed, the reviewers complemented the product profusely. Even so, Crane and unnamed others (1992c) responded at length to the negative points in the review.

Examples of the Perseus Hypermedia User Interface

Crane and Mylonas described the user interface through examples. They said if a user sees the name "Pindar," then he or she should be able to call up a description of that name. Perseus should allow students to "jump" from text using unknown geographic names to maps illustrating the location and nature of those names. Perseus should allow students to access literary references by having a window open which displays the work in question. Maps should appear in chronological sequence to show events of a period one after another. Sound should be used to convey the flavor of Greek lyric poetry or music (Crane and Mylonas, 1988).

The first part of the hypermedia design interface described above which allows non-linear access of information does appear in the current version of Perseus through a pull-down menu called "Links." The atlas is not fully implemented in Perseus 1.0 to allow for the navigation described above. Except for the voice-over commentary on the videodisc, sound is not a part of Perseus 1.0. The beta version of Perseus 2.0 has a completely redesigned atlas, but the other features mentioned above have not been implemented.

Project Evaluation

The original Perseus Project proposal included plans for evaluation and change. The Perseus Project Evaluation team believed that the characteristics of Naturalistic Inquiry (NI) make it particularly appropriate to evaluate the complex, multifaceted Perseus environment (Neuman, 1991). The interview questionnaires were open-ended. A synopsis of a student questionnaire follows:

1. How would you evaluate the overall effectiveness, attractiveness, and usefulness of Perseus?
2. How easy was it for you to navigate in Perseus?
3. How easy is it for you to learn with Perseus?
4. Do your instructors use Perseus effectively? Explain.
5. What can you suggest to improve Perseus as an instructional and/or research tool?
6. What else is important for us to know about what you think and want you do because of Perseus?

The four areas included in evaluation reports were teaching, learning, system, and content. Perhaps Neuman's most telling reaction to the evaluation was the following:

> Observations and interviews suggest that one of the most significant contributions to the Perseus Project is the development of pedagogical strategies that capitalize on the hypermedia environment. Usually, these seem to arise intuitively from the staff's teaching experience and expertise rather than from the theories and procedures of systematic instructional design. Several instructors, for example, came upon the idea of using tools outside Perseus to create dynamic outlines that serve both as organizers for lectures and as vehicles for moving in and out of the Perseus databases in both planned and spontaneous ways. (p. 245)

The bottom line here was that Neuman had identified the need for improving the instructional design of Perseus. At the very least, copies of the materials developed by these instructors who used Perseus at beta test sites should be included with the purchase of Perseus 1.0 until Perseus 2.0 is released. The instructional design of subsequent releases of Perseus should be improved to respond to the problems encountered by the instructors cited above. Subsequent versions of Perseus should rely more on sound instructional design that makes the product more user friendly than on creative instructors who are willing to develop auxiliary materials to use the hypermedia aspects of Perseus effectively.

Evaluation Results

The results of a three-year evaluation of Perseus were contained in lengthy article by Marchionini and Crane (1994) in the *ACM Transactions on Information Systems.* The evaluation touched on a number of instructional design issues. However, the evaluation was summative, not formative, in nature. The changes suggested for improvement were more likely to target the learner than the product.

> The evaluation effort described here involves a complex system (Perseus) based upon a new technology (hypermedia) applied to abstract goals (finding relevant information, learning how to think critically). The overall evaluation effort aims to inform general hypermedia application design, develop human-computer interaction and information-seeking behavior theories, and add to our understanding of learning and teaching. (Marchionini and Crane, 1994, p. 6)

Implicit Links

In a section called "Design Decisions," the Marchionini and Crane article explained that the philosophy that guided the creation of Perseus was "most strongly represented in the decision to use primarily use implicit rather than explicit hypermedia links" (p. 12). This was done in order to "make it possible for the user to browse the database flexibly and broadly" (p. 6). Hughes (1988) explained that an implicit link was basically a keyword approach to information retrieval where clicking on a keyword called up information in the database that was associated with that word. In Perseus, the traditional keyword notion has been extended to include such non-text objects as maps, sculpture, coins, urns, drawings, and archaeological sites. While I applaud this particular design feature of Perseus, it should be improved by providing local and/or global maps to provide the user with a sense of location.

Marchionini and Crane gave another reason for using implicit links: to create a situation where "the indexes and tools are specific to the underlying databases but not integrated with them. Thus, files containing text or graphics were distinct from the implicit links and can be managed and transported separately" (p. 13). This decision possibly made it easier to write the programming code necessary to access the database, rather than on using sound instructional design. One instructor estimated that it took him 20 to 25 hours "just to develop that one exercise because I had to eyeball all the pictures to make sure I was choosing the right one" (Marchionini and Crane, p. 27).

This aforementioned decision to use links which isolate the databases for images and storing images on the CD-ROM and videodisc means that the images take several seconds to appear. Akseyn, McCracken, and Yoder asserted in their 1988 article entitled "KMS: A Distributed Hypermedia System for Managing Knowledge in Organizations" that to be effective, hypermedia systems must execute linking with very short response times of less than one second.

Mechanical Advantage

Marchionini and Crane pointed out a salient but sometimes overlooked or unmentioned feature of such a product as Perseus. They called it the "mechanical advantage" of using Perseus to save the time normally spent time traveling to and from a library or museum, locating books or objects, turning pages, and visually scanning texts and lists for possibly relevant passages. Of course, the other side of the coin is that students may not have easy access to an institutional copy of Perseus and, once they get access, the higher cognitive demands of interacting with a hypermedia product may prevent some students from accessing the necessary information and making the required connections between various databases in Perseus. Hence, there was and is a need to improve the instructional design for Perseus in order to allow users make more effective use of this "mechanical advantage" that Perseus provided. The creators of Perseus might well have had this mechanical advantage in mind because of students' complaints that studying the classics meant spending more time finding information than using it.

Classical Content

For one not versed in the arcane content of Perseus nor in the type of assignments made in the classics, the studies presented in the Marchionini and Crane evaluation article to test Perseus provide an insight into the study of the classics. There may be to be a direct connection between the information stored in Perseus and way in which the access was designed and the very nature of studying the classics. As such, since this is such a specialized body of knowledge and access design, Perseus may not be the model that works in other academic areas, as its creators had envisioned. The studies cited in the Marchionini and Crane article have been selected based on what is typically expected in studying the classics. They show that Perseus generally allows students to perform as well as and sometimes better than those students using traditional methods of access to this information. However, there is no reason to suppose that a hypermedia design that supports knowledge acquisition in Greek civilization will necessarily transfer to other academic areas where less rigid or different standards and methods of study are used.

Student Performance

The second conclusion of the Marchionini and Crane article is worthy of special attention:

> Perseus was not found to change overall student performance on traditional representations of critical thinking such as translations and essays. The mechanical advantages offered by early implementations of Perseus were not alone sufficient to produce superior translations or essays. Perseus did, however, allow some students to produce superior arguments. (p. 25)

The news for Perseus supporters was not all bad. First, students using Perseus did not do worse than those using traditional materials. In fact, they did just as well if not better. Given that library access is moving in the direction of CD-ROMs and other such interactive storage mediums, students in the future will come to Perseus better prepared to take advantage of its hypermedia storage and retrieval capacities. As for instructors, the aging professoriate will eventually be replaced by computer literate faculty who will better equipped to take advantage of Perseus in the classroom. Second, student and faculty performances will improve if the instructional design of Perseus, especially with the visual interface presented to users, is improved.

The Status of Perseus

Perseus 2.0 has not yet been released although release dates as early as December, 1993, had been promised in the past. From the introductory comments in the beta version of the Perseus 2.0 User Manual, the managers stated that Perseus has achieved the goals set out in the original conception of the project. In this author's view, the interface design of the beta version of Perseus 2.0 shows no change in the design philosophy that guided the creation of Perseus. Although the support strategies, such as a newsletter, a web site, and internet access to experts, continue to evolve, none of the basic navigation and interface design deficiencies of the Perseus 1.0 were addressed by Perseus 2.0.

Design Recommendations

The list of suggestions below is not meant to be a definitive, but it is indicative of what design considerations should be addressed in order to improve the Perseus interface.

1. **Redesign the Gateway (see Figure 1).** Call the 2-column Gateway either a temple (which is what the 5-column icon with pediment looks like on the "navigator" bar) or a library (since the gateway is really a menu repository). If the gateway is a metaphor for entering these various areas of Greek culture, a temple or library would be a better metaphor since the gateway metaphor does not imply storage. When this author encountered "dead-ends" in Perseus and used the Gateway button to extricate himself, his frustration in the sense of the gateway metaphor was heightened since he was so lost he was forced to re-enter Perseus by the main gate. To this author, returning to the temple or library where materials are stored is far less threatening.
2. **Provide local and/or global maps (browsers) so that the user has a sense of location in order to navigate more effectively.** Perseus should be ready to suggest to the disoriented user possible paths to follow from the present screen. A graphic environmental map should be provided which is based on some concept or visualization familiar to the user (Tolhurst, 1992).
3. **Use a consistent navigation interface for the various kinds of storage.** The navigation buttons are placed inconsistently at varying screen locations for various kinds of data. The interface should be consistent. The location of important text and buttons, selection methods, text fonts and styles, and window layout should be consistent in all parts of the interface (Cates, 1992; Marchionini, 1991).
4. **Have dedicated areas for frequently used functions such as navigation (see Figure 2).** Perseus should be redesigned to take advantage of the larger screens on today's computers. There is room to design a consistent user interface that does not pop up all over the screen with each new type of database and does not get covered when subsequent windows open.
5. **Use color throughout the interface.** Not only is color pleasing to the eye, it helps learners differentiate between various fields and objects at a glance. Certain functions and classifications, such as navigation and collections, could be color coded in a consistent manner.
6. **Redesign the links so that one can browse through the images using the arrow keys.** Due to the linkage design used to make the databases transportable, one cannot browse through the databases of stored images. One must painfully call each one up by name from a menu. Navigation should be simple, intuitive, and

consistent throughout the system (Kearsley, 1988). Introduce backwards linking so that images can be easily connected to their descriptions that may have been closed or covered.

7. **Avoid screen clutter with list after overlapped list appearing on the screen.** Program Perseus for the larger monitor screens now available so that the images appear, as much as is possible, in non-overlapping positions. Since image credits are rarely used and a nuisance to deal with, offer the user an opportunity to set the system to "no credits." Since visual layout is very important, screens should be laid out so that they can be grasped perceptually (Kearsley, 1988).
8. **Cut down on the use of so many lists and menus.** If possible, create visual interfaces to allow the user to use the navigator more intuitively. Expert users should be given the ability to move through layers of menus quickly (Marchionini, 1991). Add keyboard shortcuts for frequently used menu items to save time.
9. **Give the choices in menu lists more interesting or descriptive names.** A list such as vase 1, vase 2, vase 3 or poem 1, poem 2, poem 3, etc. gives the user no clue as to what they are choosing. Users might have complete access to "jump" anywhere they like in Perseus, but these lists provide no guidance as to where to jump. Thus, time is wasted, and frustration may be the result.
10. **Design the screen more effectively to indicate the hierarchical nature of the menus that appear.** Reprogram so that images of objects, sites, and menus pop onto the screen in a more consistent manner. Given the larger screen, a column or row of icons might be used (like the toolbar in the latest versions of Microsoft Word) in order to replace the lengthy "Links" and "Perseus" pull-down menus.

Suggested Interface Design

What follows is a suggested interface design for the main screen that would take the place of the Perseus Gateway (Figure 1). This design takes into account many of the recommendations made above. The most significant improvement is that the navigation controls now present in the Perseus Gateway do not disappear when a user begins to use the program. There is no longer a need to return to the Gateway controls when a "deadend" is encountered since these controls are omnipresent.

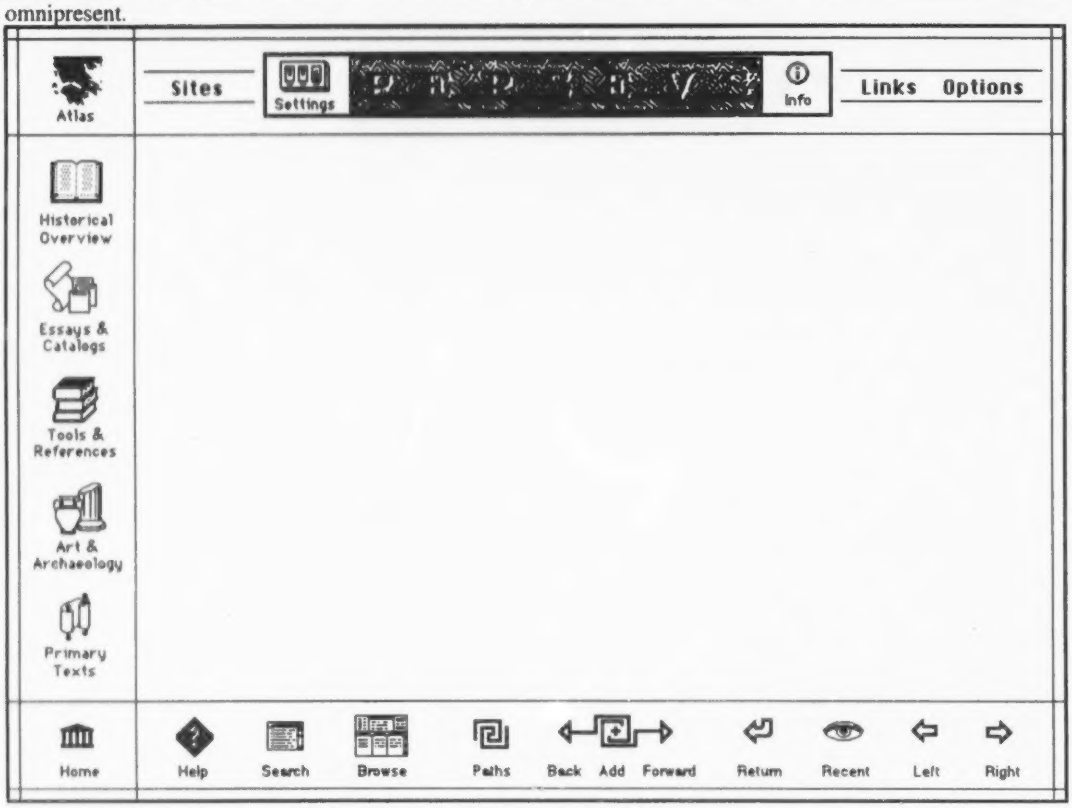

Figure 3. Suggested Interface Design to Replace the Perseus Gateway

The HyperCard menu selections have been deleted along the top of the screen, but the three pull-down menus (Sites, Links, and Options) dedicated to Perseus activities have been retained. The nebulous "Perseus" pull-down menu name has been replaced by "Options." Since the "Temple" icon on the Perseus Navigator (Figure 2) is no longer needed to return to the Gateway, that icon has now been used to "Go Home" in place of the modern bungalow that appears so out of place architecturally speaking in Perseus 1.0 and the beta version of Perseus 2.0. The infrequently used "Settings" and "Info" icons have been given less prominence in this design.

The icons for the major categories in the database that previous appeared in the center of the Gateway now appear down the left-hand side of the screen in a dedicated area that is always available. For clarity, the icon for "Essays & Catalogs" has been changed to a different icon than the one for "Historical Review." The use of the same icon for both classifications in Perseus 1.0 and the beta version of Perseus 2.0 could be confusing and may lead even an experienced user to click on the wrong one. The Atlas icon now appears next to the pull-down menu used to support its usage.

All the navigation tools and devices that allow the user to move through the database are located together across the bottom of the screen and available at all times. Names have been added to the buttons that previously appeared in the Perseus Navigator in an unnamed form. The Perseus "Footprint," the double-ended arrow icon with the maze in the middle, has been lengthed and lebeled so that users will be reminded of its three-fold functionality. The "plus sign" in the center reinforces the notion that one can "add" stops on a pathway by clicking on it.

The "Recent" button with its "eye" icon permits the user to view the last forty-two screens used in HyperCard. For those unfamiliar with this HyperCard feature, a user need only click on the thumb-nail version of a previously visited screen for the application to jump to that screen. The reason for this addition to the navigation is that the link structure in Perseus does not premit the "Return" button with its "curved arrow" icon to work properly. The Perseus 1.0 and beta version of Perseus 2.0 User's Manuals recognize that fact and suggest that users use the pull-down manu in HyperCard to access the "Recent" command when they find they are at a deadend because the "Return" button does not work. The repeated use of the Return button often leads to infinite loops where the same screens appear again and again. The Recent button allows the user to break the cycle in order to continue working in the database at a point before the impasse occurred.

Conclusion

A larger consideration than the hypermedia design suggestions listed above is the fact that the beta version of Perseus 2.0 has not made any significant instructional design changes from Perseus 1.0. Rather than expecting learners to adapt to the eccentricities of Perseus design, the design of Perseus should have adapted to the needs of learners. More people need to be allowed or encouraged to become involved. Instructional design experts need to be consulted to contribute their expertise. Given the advantage of heavy funding, Perseus will not be challenged in the near future. However, the chosen direction of the Perseus was to get bigger, not better. Except for the atlas, instead of improving the interface design, they kept what they had and added more features. The goal of attracting students to buy their own copies of Perseus will not be achieved by retaining an interface design that is cumbersome to use.

As for the Perseus Project being used as model for other academic areas, its application in that direction is limited by two problems: (1) the fact that only one version of Perseus has appeared in seven years, and (2) the price of Perseus. Relative to problem (1), the CDI (Compact Disc Interactive) product currently being offered by Phillips (that included a *Compton's Pictured Encyclopedia* on CD-ROM for $500 total) should make it clear that commercial vendors are not going to sit back and wait for the members of academe to decide how to design informational products. Manufacturers will simplify produce and sell what they can as quickly and economically as they can. When the dust clears, the best sellers (the market place) will have determined what many will consider to be the best design characteristics for hypertext and hypermedia systems.

Relative to problem (2), all the faculty members who teach calculus at my institution received complimentary copies of a CD-ROM with an entire calculus book stored on it. The point is that vendors are willing to give away CD-ROMs on mathematics to induce faculty members to adopt their materials. Compare that to the current $150 price tag on the Perseus 1.0 CD-ROM with user's guide or $350 for the entire package which includes the videodisc. Some innovative marketing ideas should be used to get the Perseus Project moving again after its promising start over seven years ago.

Before Perseus can achieve the status of being a design model for other subjects, Perseus must first incorporate design changes to make the product more user friendly by being more visually interesting while maintaining a consistent screen design. The navigational problems alone make this design impractical for most learners except for the most motivated who will learn in spite of the instructional materials used. At this stage in its development, Perseus is an adequate model for esoteric academic areas where its "mechanical advantage" to access encyclopedic information databases can be exploited. However, Perseus 1.0 and the beta version of Perseus 2.0 do not exhibit any special design characteristics that would make it a clear choice over other products which are currently being developed for mainstream instructional applications.

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Title:

Building Coping Skills on a Firm Foundation: Using a Metaphorical Interface to Deliver Stress Management Instruction

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In 1986, when the concept of a graphical user interface (GUI) was still new, Norman challenged designers of computer-based programs to heed the needs of the user. He contended that interface design should stand separate from the needs of the system; in fact, the system should be "transparent" to the user. As far as the user is concerned, Norman argued, the interface *is* the system.

Ten years later, GUIs are everywhere. Apple Macintosh and Windows desktop GUIs dominate the market. Software developers vie to see who can release the "more graphical" program. Users now recognize icons and buttons as staples of most interfaces, and many, especially the young, have grown increasingly sophisticated in their taste for attractive interface design.

Utilizing Metaphors in the Graphical User Interface

Laurel (1993) contended that "an interface is not simply the means whereby a person and a computer represent themselves to one another; rather it is a shared context for action in which both are agents" (p. 4). As graphics have become increasingly more sophisticated and dominant in the human-computer interface, they offer users opportunities to process and interact with information in ways likely to be richer than text alone. Brown (1988) asserted that an important advantage of graphical presentation is in increasing the rate at which users can process, understand, and respond to a display. But the presence of graphics alone does not assure Norman's "transparent" interface. In fact, including graphics may actually make the interface less comprehensible. Increasingly complex graphics, like the sirens of mythological fame, lure us ever closer to foundering and failure. But, if graphics, in and of themselves, do not enhance comprehensibility and help users understand how to make the most of a program's promise, what does? Perhaps metaphorical interfaces do.

A metaphor is a figure of speech which applies its symbolic images to a subject, to improve our understanding of that subject by linking the familiar with the unknown. Paivio (1979) argued that a metaphor acts as a *vehicle* when used in conjunction with another object, a *topic*, to impart a similarity or relationship which helps render the new knowledge we are acquiring intelligible. Lakoff and Johnson (1980) asserted that metaphors are a pervasive part of our speech and thought, used to understand and experience one kind of thing in terms of another. Erickson (1990) agreed, suggesting that metaphors are invisible webs of terms and associations that underlie the way we communicate.

Metaphors can convey rich images and chunks of information that hold more meaning than the literal definition or singular implication of the phrase used as a vehicle. When people perceive the presence of a metaphor, they explore a range of potentially applicable emotions, sensations, and mental images. This range and its components appear different for each individual, but are tied in some way to individual experiences and imaginations, helping to build individual cognitive models (Lakoff, 1987; Ortony, 1979; Petrie, 1979). In fact, Black (1979) contended that "every metaphor is the tip of a submerged model" (p. 31). But the model's existence does not mean that the user must accept the complete package of implications for the metaphor to work. Rather, Black argued, the perceiver selects, organizes, projects, and suppresses portions of the metaphor as needed to facilitate comprehension and, at the same time, codes both the topic of the metaphor and the vehicle into long-term memory (see also Mountford, 1990; Paivio, 1979).

According to Rieber (1994), graphics in the computer interface can take a number of forms, particularly for computer-based instruction. They can be arbitrary, like a graph which illustrates a logical or conceptual relationship. They can be representational, like an illustration of two people having an argument. Or they can be analogical, as when an image of two knights squaring off in a jousting match represents two people in an argument. Analogical graphics might also be described as visual metaphors. Visual metaphors in interfaces can share the same properties as the ones we use in speech, according to Dent and Rosenberg (1990). The authors argued that as a verbal metaphor acts as a vehicle to describe or explain a less familiar topic, a visual metaphor depicts a vehicle object using properties that are recognizably related to the topic object. As illustrated in the clip art cartoon of Figure 1, the most important properties, those which exemplify the connection between vehicle and topic, are emphasized in the visual metaphor. The vehicle, an office worker, is revealed by just a few properties: a desk, chair, and typewriter. His dilemma is indicated by the sweat pouring off his brow and the canoe heading over the falls. The state of "teetering on the brink" is a metaphor for the topic, apparently a deadline that is fast approaching.

Graphical user interfaces can integrate images more fully than just an occasional spot illustration. They can employ icons, small graphical representations to indicate interactive objects, actions, or concepts. GUIs can also utilize large graphical images to represent something other than the actual computer screen. Those large graphical images can be integral to the meaning and the action of a computer program, and they can be metaphorical in nature.

What a metaphorical GUI has to offer

Engagement. Laurel (1993) contended that an interface metaphor can serve as a "mimesis," a functional representation that encourages the user to become engaged, to participate, to willingly suspend his or her disbelief as we do for movies and plays. Such a metaphor, which Keller (1983) called a metaphoric organizer, can grab the user's attention while acting as an advance organizer for the actual content, in a sense planting clues for the user to pick up, developing a sense of expectation. Keller argued that using such an organizer can help students relate a more abstract concept to a familiar, concrete one, build curiosity, and add to an effective learning experience.

Orientation. A metaphorical interface may help users learn how to use a program or system. Unless we design it carefully, however, an opposing disadvantage might be that the metaphor could break down as the novice learner moves toward expertise, developing an understanding of the system or program that can extend beyond the metaphor's utility (Laurel, 1993).

Familiarity and Transfer. Hammond and Allinson (1987) asserted that a primary strength of metaphors lies in their familiarity. The authors developed and tested a "travel holiday" metaphor to aid users in navigating a general knowledge base. Their results suggest that once the user has established the primary relationship between the metaphor and the topic to which it relates, secondary relationships can be more easily established as the user retrieves familiar knowledge and actions from the metaphor's domain. They termed this "piggy-backing." The authors argued that metaphor use reduces the need for inference and logical thought. Plausible but erroneous mappings of the metaphor to the topic can, however, occur if the designer has not considered such mappings and their causes in advance. A designer who has so considered potential mismappings should be able to suggest additional useful aspects of the metaphor to decrease the likelihood of their occurring.

Bielenberg (1993) concurred, asserting that visual metaphors in GUI instructional programs can be one of the most powerful ways to transfer meaning. He used as an example a "Test Drive" program, designed with a metaphor of a car dashboard and driver controls to convey technical information about the capabilities of digital video interactive (DVI). Bielenberg contended that a user who is familiar with automobiles brings to the instructional program a mental model of the functionality of the car's dashboard and controls. The designer offers a conceptual model, a structure composed of the content to be taught, the task to be performed, or the information to be displayed. The purpose of the interface, according to the author, is to encourage the user's mental model to conform to the designer's conceptual model quickly, completely, and painlessly. He asserted that visual metaphors can support that process and urged designers to analyze the needs of the learner and the structure of the content when choosing a visual metaphor.

Coherence. Providing coherence is another advantage of integrating a metaphor into the interface, according to Laurel (1993). If the metaphor is well-chosen, all of the elements of a program or system should cohere naturally, for example, as files in the Macintosh desktop fit into folders. Cates (1994) refers to this as the presence of complementary auxiliary metaphors, in this case to accompany the underlying metaphor of a desktop. Of course, limitations of this metaphor's implementation become evident when users begin to look for other "items" they expect to see on the Mac desktop, like staplers and paper clips, and fail to find that functionality, or when they find a trash can on top of their desk. This latter example is an instance of a confounding auxiliary metaphor (Cates, 1994).

Implementing a Metaphor to Deliver Instruction on Stress Management

The pervasiveness of stress in our lives makes stress management a popular topic. Selye (1981), considered the father of modern stress theory, contended that stress is inevitable. Without it we would suffer from a lack of motivation and drive. Many workshops, books, and tapes exist on stress management, and many techniques to reduce or cope with stress have met with varying degrees of success.

Any adult who remembers his or her college years as idyllic and stress-free is probably exhibiting a case of selective memory. According to Benjamin (1987), college students, particularly freshmen, face many new responsibilities. Among them are organizing their time, handling new social and administrative interactions, adapting to large numbers of students who are unknown to them, and often facing much more rigorous academic performance standards. Stress naturally accompanies these new responsibilities. A recent World Wide Web report by the Counseling Center of the State University of New York at Buffalo (1995) listed stress periods for students by month. Every month of the student's academic year held a bulleted list of at least four stressors or stress reactions based on academic and other aspects of normal college life.

Computer-based instruction on stress management

A computer-based instructional (CBI) program about stress management could be quite large, since stress ideally should be managed on a number of levels -- physiological, cognitive, emotional, and behavioral (Roskies, 1987). In order to narrow the field to a manageable size for testing the implementation of a visual metaphor, the researchers have chosen to develop a CBI lesson for college students on 1) the fundamentals of stress, and 2) the role of time management as a coping strategy. The fundamentals of stress include building an awareness of specific sources of stress for college students, and identifying ways to cope with stress by managing it effectively, utilizing available support mechanisms. The portion of instruction on time management will attempt to validate a model developed by Brown (1992). Brown suggested that students first map the time allotted for various activities against the available time in each week. Next, they evoke memories and a visual representation of the past semester's peak stress periods. Last, they practice ways to handle moderately increased stress now in order to reduce it significantly later.

Description of content

The instructional program, called "Building Coping Skills on a Firm Foundation," begins by offering nine categories of college student stress (Johnson, 1978): instruction, competition, managing time, adjusting to college, administrative problems, social adjustment, finances, housing, and transportation. Students are informed about the particular relevance of stress and stress management to their lives. Students then examine how to react to the addition of a new stress factor and explore the relationship of balance in the realms of physical health, psychological health, academic obligations, and social life (including the support of friends, faculty, and professionals) to coping with stress. They learn about the forms that stress can take, and add personal descriptors of physical and emotional signs of stress.

Beginning a decision-making exercise involving a proposed new stress factor, students chart a weekly schedule, dividing hours of the week into categories for sleep, eating, classes, and other components. They note the number of hours left for study and compare them to an ideal. Given the added stress factor, students practice coping by adjusting their schedules, assessing the effects of their adjustments on the various components. Feedback offers pros and cons about those adjustments (for example, the effects of inadequate sleep). The program analyzes the results in terms of a healthy balance of physical, academic, social, and psychological needs and provides a running stress assessment report. In a final metacognitive exercise, students select the ten ideas most useful to them from a given list of ideas about how to improve time management skills for study and living. They select and drag them to a report form, adapt them, add new ideas, and print out the resultant form.

The role of a metaphorical GUI for this program

Engagement. Many of us view the efficacy of our actions on a daily, even moment-by-moment basis, rarely taking the time to step back and take a long view. Most of us feel that at any given time we are doing the best we can. Though stress is neither the province of the young nor the old, college students can often find themselves in difficult and stressful situations, compounded by their youth and inexperience. Brown (1992) discussed the motivational conflicts students can face when they confront at least two simultaneous choices. One is usually academic in nature, with delayed reward (grades) and remote consequences (positive or negative reinforcement in the classroom, future career choices). The others are often social activities, with immediate reward (exercise leading to a sense of physical well-being, the pleasures of food and drink, positive reinforcement from friends). Given a natural tendency to be short-sighted, some students might predict that an instructional lesson on stress management would be dry, "preachy," and an inaccurate reflection of their lives. Introducing the lesson with a metaphorical GUI before they meet the lesson's content could serve the purpose of engaging learners, as Laurel (1993) argued, to participate, to buy in, and to suspend their disbelief. The metaphor should be concrete, comprehensible, and familiar enough to all college students that it would not cause cognitive dissonance nor lose the audience. Learners should suspend their disbelief on participating in the "mimesis" willingly, not reluctantly.

Orientation. As with most instructional computer-based programs, there are uniform conventions of use, like a stop or quit function, the ability to navigate, and expected responses to data input. But there are also unique elements in the functionality of any program. A metaphorical GUI could help learners become oriented to both predictable and unique functions by placing all functions in a consistent context. For example, elements of the metaphorical interface could indicate properties of use, such as a "report" in which data can be entered, or a set of binoculars which could magnify a view or provide deeper insight. Expected functions could be portrayed in ways consistent with the metaphor; for example, a building construction site might display its stop function in the form of an EXIT sign on the fence surrounding the site.

Familiarity and Transfer. We have already noted that our lives seem intimately familiar to us. Yet life can hand us lemons and, at any given time, we may have greater or lesser abilities to make lemonade. Similarly, the subject of stress and our ability to cope may seem familiar territory, yet it may not be as familiar as we think. Lakoff and Johnson (1980), paraphrasing Aristotle's Rhetoric, suggested that metaphors are one of our most important tools for trying to comprehend partially what cannot be comprehended totally -- our feelings, aesthetic experiences, moral practices, and spiritual awareness. A metaphorical GUI portraying a familiar setting, situation, or event can offer a more concrete framework to help learners acquire new ways to picture what may not be comprehended totally. In effect, the metaphor can provide learners with a conceptual fix on what may always be a moving target, as feelings change constantly and stress levels ebb and flow. The designer can encourage learners to bring their mental model of the metaphorical GUI to the instructional event, as Bielenberg (1993) suggested. The learner's mental model, or schema, should support his or her new understanding of the topic if the designer's conceptual model of the content is mapped well to the needs of the program's users and to the metaphorical GUI.

A mental model may be particularly important to the content in this case because the chosen lesson focuses on relational concepts: a balance of finite resources (time, health, academic requirements), personal responses to stressful situations, and decisions affecting short- and long-term goals. For college students, stress can be found in as many as nine categories. Each category can be perceived as a layer that each student must handle, and the weight of those layers can pile up intensively and with disastrous consequences, should the student not have a strong enough "foundation" to bear the weight. In addition, each individual has a propensity to respond in a number of different ways. Some may tend to ignore the problem until they sink under the weight. Others may put a temporary "patch" on the situation, risking future complications, while others will stop and focus long enough to assess the problem and address it as definitively as possible. In this case a visual metaphor could build a fitting mental model to help learners transfer their new knowledge to future stress-related events beyond the scope of this lesson, helping them imagine ways to adjust those relationships in order to successfully cope with new problems.

Coherence. Finally, a metaphorical GUI can provide this stress management program with visual elements that tie the metaphor to the content throughout the lesson, providing a sense of coherence and reinforcement for the functionality of the learner's mental model in representing the content. All elements of the metaphor should logically and coherently support the lesson, including the presentation of information, the exercises, feedback, reports, and opportunities for practice. All auxiliary metaphors should, therefore, be complementary.

Components of the metaphor

For this program, "Building Coping Skills on a Firm Foundation," the primary metaphor is a building construction site. The learner enters the program as a new manager of building construction. The building, a new student center for the fictional Piloton University, consists of a foundation and a number of framed-out stories. As the brief story line develops, you, the new manager, are made aware by other employees that your boss, Ike N. Cope, has authorized the addition of four more layers, or stories, to the building. Figure 2 shows the building under construction. The building represents the life of a student, supported by a foundation of physical health, and including layers, or "stories" of stress factors, including academic requirements, competition, financial pressures, and other components listed above.

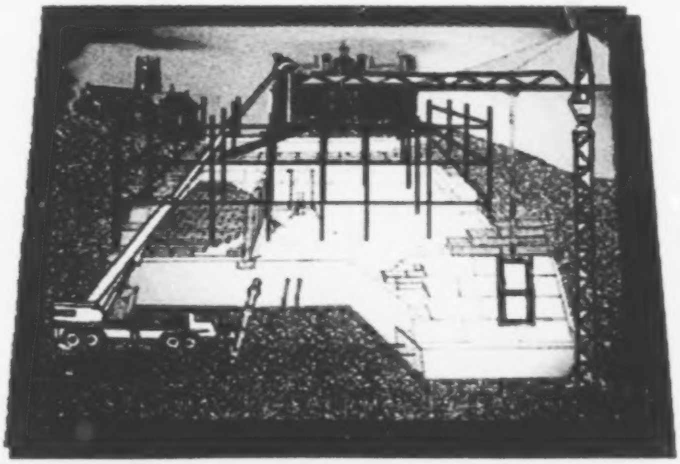

Figure 2: **Building under Construction**

The manager, of course, manages construction of the edifice, just as learners manage, with greater and lesser degrees of success, the components of their lives as college students.

As the introductory plot develops, another coworker points out that there is a problem in the building's construction. A crack has appeared in a support beam, and a connected beam has started to bend. The coworker implies that there may be a problem with the foundation, particularly if it must support the weight of additional floors. As manager you are faced with an immediate choice: to ignore the construction problem, to "patch" it, or to stop construction briefly (for everyone's safety) and plan the best way to deal with it. Animation sequences and "faxed" feedback from the remote boss can demonstrate the results of these choices to the primary metaphor, the building and its foundation. As the program moves from the metaphorical GUI's story to a more content-intensive lesson, learners will again face this dilemma as an unexpected theoretical stressor is added to their lives, forcing them to examine the results of the same coping choices: ignore, patch, or manage it. Feedback is again given, reflecting the images and language of the primary metaphor. Thus, the tools of the metaphor come to be the tools of use in the realistic setting, a form of near transfer.

To help designers develop metaphorical GUIs that effectively support instruction, Cates (1994) suggested a method for identifying related properties of a primary metaphor. Called a POPIT approach, this method identifies a prospective metaphor's properties, operations, phrases, images, and types. A POPIT approach can reveal bad news and good news. The good news may be that a metaphor offers a rich environment of secondary metaphors, consonant components to support acquisition of new knowledge. The bad news may be that a component of the metaphor is dissonant, leading to rejection either of that component or –if it can't be ignored– the whole metaphor. However, the bad news is actually good news for the learner, who will have avoided a potentially irritating learning experience.

A POPIT of the building construction site metaphor revealed a number of useful secondary metaphors. One, a blueprint, shown in Figure 3, indicates the four extra floors that should be added to the student center. Each floor contains rooms or offices representing some of the stressors typically faced by college students: academic requirements, financial needs, career, and so forth. The top level, a recreation center, represents the need for friends and relaxation time, but can also represent a source of stress if time dedicated to recreational activities (and recovery time for some of them) is not managed reasonably.

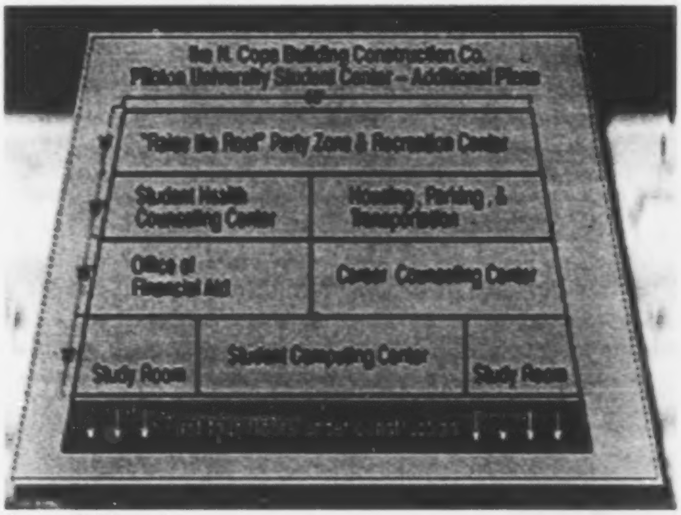
Ike N. Cope Building Construction Co.
Pilton University Student Center – Additional Plans
"Raise the Roof" Party Zone & Recreation Center
Student Health Counseling Center
Housing, Parking, & Transportation
Office of Financial Aid
Career Counseling Center
Study Room
Student Computing Center
Study Room

Figure 3: Blueprint

While the physical factors are represented by the building's foundation, Figure 4 reveals auxiliary metaphors for the three other factors of college student life that require balance in order to manage stress: psychological health, academic obligations, and social life. "Your" hand holding a pocket watch and a list of problems that must be addressed represents academic obligations. Some workers at the construction site represent auxiliary metaphors for social life. The lower right corner of Figure 4 shows four construction workers helping each other by carrying two beams between them, representing the support of friends. Another worker sits on a beam bearing the American flag. He's waving and happy, motivated to do his job well and with pride. This worker is an auxiliary metaphor for psychological health. Though this

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lesson focuses primarily on time management as a coping strategy for the strain of additional stressors, the other elements are noteworthy and necessary. To illustrate the relationship of all four factors to each other, the learner is presented with a conundrum: what if the foundation's strong, your project is on time, the teams are working well together, but a few workers are depressed? What if any other one of these factors is out of kilter? This same kind of conundrum reoccurs later in the instruction, this time dealing with actual content. Reinforcement is provided as the content is tied to the appropriate metaphoric images.

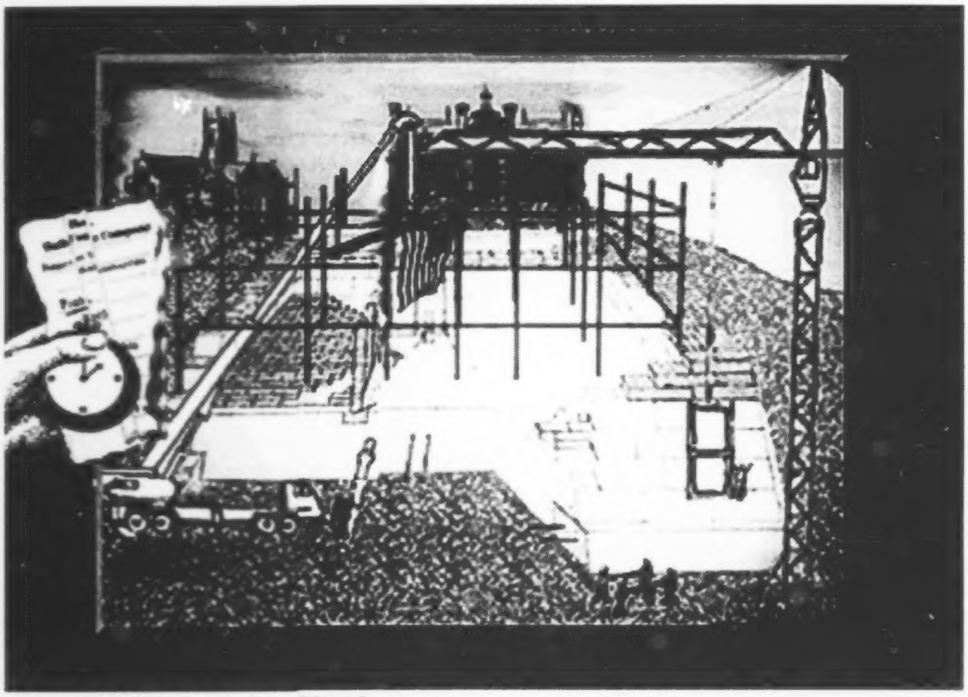

Figure 4: Additional Auxiliary Metaphors

Besides the blueprint, the workers, and the pocket watch, another set of auxiliary metaphors, business forms, provides coherence to this program's functionality. As mentioned earlier, after students are given a new stress factor they are presented with a decision-making exercise in which they practice how to manage their time. They take a comprehensive look at the hours they spend at various activities, dividing the hours of the week into categories. They practice coping by adjusting their schedules, and receive feedback in the form of a stress assessment report. Finally they develop a report containing ideas about how to improve their time management –and thus coping– skills. Doing this exercise requires three forms, shown in Figure 5 below: one for students to chart and adjust hours spent, one to provide feedback to the learner, and one for each learner's personalized coping ideas. As auxiliary metaphors, these forms can take the guise of a spreadsheet, a stress assessment report (a play on words for "stress" as a strain to the foundation and beams), and a memo.

Visual reinforcers

In addition to the use of primary and secondary metaphors, this program uses color selectively. Primarily black and white, the metaphorical GUI uses select areas of color to focus the learner's attention. For example, on the screen in which a coworker indicates to the manager that there is a construction problem, the only item containing color is a set of binoculars the coworker offers to the manager. In Figure 4, only the team workers, the pocket watch, and the worker with the flag are colorful. The learner's eye is directed by color and by text cues to attend to selected portions of the screen. This treatment has the added benefit of rendering the computer program a more manageable size without giving up important design elements.

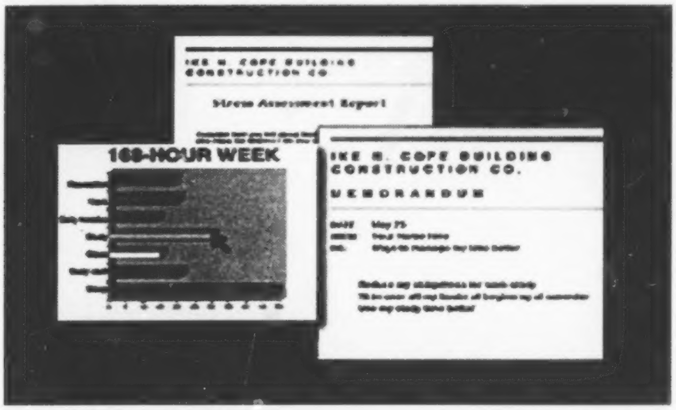

Figure 5: Spreadsheet, Report, Memo

The Field Test

Upon completion, "Building Coping Skills on a Firm Foundation" will be tested with a sample population of approximately 150 college students, both freshmen and upperclassmen, to determine if the metaphorical graphical user interface contributes to the students' understanding of the relationship of time management to coping with stress. The program will be tested in two formats: half of the sample will utilize the program with content tied into a metaphorical GUI, while the other half will use the format containing the stress management content without a metaphorical GUI.

"Building Coping Skills" will be validated by a group of experts on stress management for college students. This group will confirm that the metaphorical implementations have content and construct validity, particularly for Brown's (1992) model for time management. They will also help to derive the optimum "healthy" balance of physical, academic, social, and psychological needs. An initial pilot test will be conducted with a small group of college students to help improve interface and implementation effectiveness. The researchers will interview students for feedback on comprehensibility of the subject matter, clarity or ambiguity of visual images, accuracy, ease of use, and relevancy.

After the program is revised based on the evaluators' feedback, it will go to a main field test. The program itself should take approximately an hour to complete. Faculty or other observers who supervise the program's delivery will be trained for inter-rater reliability to assess the performance of each student on completion of the program. In addition, the computer system will retain performance logs of student usage (audit trails). Students from both groups may participate in pre- and posttests to measure individual differences in levels of anxiety as indicated by the State-Trait Anxiety Inventory. The researchers may also test for visual versus verbal cognitive styles, to determine if there is a correlation with the ability to internalize and utilize a new mental model (Jonassen & Grabowski, 1993). A posttest questionnaire will again elicit reactions to comprehensibility of the subject matter, clarity or ambiguity of visual images, accuracy, ease of use, and relevancy. Finally, two weeks later, the researchers will conduct follow-up interviews of a subset of students to determine if the construction site metaphor succeeded in building a lasting mental model. When these students are asked about friends suffering from stress, will they incorporate terminology and analogies from the construction site metaphor in their responses?

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Title:

A Door Is a Big Wooden Thing with a Knob: Getting a Handle on Metaphorical Interface Design

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In 1986, while considering the design of human-computer interfaces, Laurel wondered what the ideal user experience might be and what sort of interface might provide it. Now, ten years later, a quick market survey might well lead one to believe that the answer to Laurel's question is the Graphical User Interface (GUI). Buttons have almost completely replaced function keys. Icons represent everything from objects to actions. Once considered extravagant, high resolution color graphics and mice are now essential. GUIs have become increasingly prevalent across all operating platforms. Despite the prevalence of GUIs, however, some users still find it difficult to operate their computers. It may be that simply employing visual representations in the interface is not enough; to realize the ideal user experience, it may be necessary to employ metaphors in interface design.

This paper chronicles the evolution of a metaphorical graphical user interface (MGUI). This particular project has been a part of the author's involvement with the Design and Development Group at Lehigh University.

What are MGUIs and Why Do We Need Them?

To understand MGUIs, one must first understand metaphors. The Oxford Encyclopedic English Dictionary (1991) defines metaphor as "the application of a name or descriptive term or phrase to an object or action to which it is imaginatively but not literally applicable." Erickson (1990) defined a metaphor as "an invisible web of terms and associations that underlies the way we speak and think about a concept" (p. 66). Mountford (1990) took this definition one step further contending that "metaphors are powerful verbal and semantic tools for conveying both superficial and deep similarities between familiar and novel situations" (p. 25). Indeed, metaphors frequently appear in both our speech and writing.

A GUI's use of metaphor is, however, more likely to be implemented visually. Despite the above definitions' failure to mention *visual* representations of an object or action to which it is imaginatively — but not literally applicable — a quick stroll through your neighborhood airport with its iconic signage should provide sufficient evidence of the prevalence of visual metaphors. In fact, visual metaphors are currently used in computer interfaces: papers, stacks, folders, directories, menus, trees, and trash cans — all generally familiar images — are manipulated on a desktop to carry out the basic operations of computers. These metaphors can be useful and efficient because they represent ways of conceptualizing these computer functions and, as Erickson (1990) argued, bring along "additional bits of structure that may be useful later on" (p. 72). And, as anyone who has been hesitant before dropping his or her file-laden diskette into Apple's trash can will tell you, these lingering bits of structure do indeed exist. In fact, because of this phenomenon, many designers have warned that the inappropriate use of metaphors can cause confusion, misunderstanding, and both navigational and conceptual difficulties for your user (Rosendahl-Kreitman, 1990; Semper, 1990; Vertelney, Arent, and Lieberman, 1990).

Assuming for now, however, that we can identify appropriate metaphors, the benefits MGUIs might offer computerized instruction are twofold: First, because metaphors help one establish expectations for how things should work (Black, 1979), MGUIs might help a student establish expectations for how an instructional software product should work. As is the case with basic computer operations within a MGUI environment where moving an electronic file is as easy as dragging and dropping its paper representation onto a folder, MGUI environments can be used to help students quickly learn the basic functional and navigational operations of an instructional application. Second, and more importantly for instructional design, because metaphors facilitate "understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 1980, p. 5), MGUIs might also facilitate the understanding and experiencing of new and abstract concepts in terms of other more familiar concepts or experiences. As has long been the case in good teaching where educators use a student's existing knowledge to help explain new curricular materials (Coker, White, & Barton, 1993), MGUI environments can be designed to help students learn content by providing "both superficial and deep similarities between familiar and novel situations" (Mountford, 1990, p. 25).

How do we keep the MGUI from becoming, as Nelson (1990) argued, "a dead weight," especially when an interactive multimedia learning environment's primary purpose is to teach? Supplying support for learner inquiries does not have to mean that the environment must be boring or limited; as we know, there is certainly an instructional need to gain attention and to motivate. What this does mean is that everything in the instructional product must contribute to the goal of helping learners acquire new knowledge and skills. This goal easily can get lost within a metaphor as its implementation grows in complexity. It is the instructional designer's task is to assure this does not happen.

One final note before we leave this section. The defining characteristic of a metaphor is that it compares one thing to another without directly stating the comparison (Cates, 1993). For example, a door might be metaphorically compared to an opportunity or a juncture with no additional explanation as to why or how they are similar. In this way, a metaphor is a statement of relation, not simply a statement of fact. Thus, to report that "a door is a big wooden thing with a knob on it" is simply definitional, not metaphorical. Although this clarification may seem obvious, many of us have discovered that creating a metaphor is much more difficult than spotting one. In fact, this catch-phrase has become a warning among the designers in Lehigh's Design and Development Group to alert us to GUIs treading dangerously close to non-metaphoricality.

Defining the Content

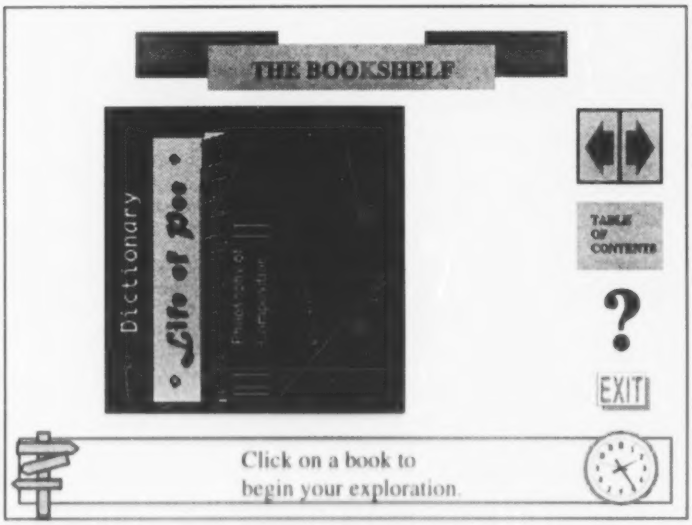
From its inception, "The Funeral of Edgar" has been a guided exploration of Edgar Allan Poe's poem, "The Raven," aimed at modeling high school students' critical and analytical reading skills. This product is targeted for the 9th-grade student (roughly 14-15 years old) enrolled in an English class with limited previous exposure to literature and even less experience with poetry. This is the kid who is "psyched" to find that her English homework for the evening consists of a two-page poem which she knows she can read in less than 30 seconds. This "MTV" approach to critical reading usually ends up with the student entirely missing the poem's meaning — bypassing parenthetical background information the textbook's publishers have so carefully added, glossing over images the poet has carefully chosen, and failing to reflect on ways their own life experiences are mirrored in the poem's themes. Although the next morning's class discussion may help in understanding the teacher's perspective, the student rarely learns how to read analytically or how to develop independent ideas.

It appears that teaching careful and analytical reading may be more difficult without first actually showing the student how it is done at the same time that the student reads (Vygotsky, 1987). Unfortunately, given class sizes and time constraints, it is almost impossible for a teacher to demonstrate critical reading techniques by guiding each student through his or her first readings. However, this kind of modeling might be possible from within a computerized lesson programmed to guide and coach each student actively through the reading assignment. For this reason "The Funeral of Edgar" is based on a guided exploration approach: although students are free to "roam," the application mediates the student's experience by providing content-sensitive help, asking questions at appropriate times, directing attention to anomalies, suggesting avenues of further investigation, calling attention to overlooked information, helping to organize the reader's thoughts, and supporting the synthesis of new concepts and schemas.

The Initial Interface

Edgar Allan Poe's "The Raven" was chosen for this application because of its reputation as a favorite among students within this age group and because the poem's vocabulary is relatively accessible and its images few. "The Raven" also addresses topics which describe the human condition — lost love, untimely death, human perspective — literary subjects which Judy (1980) argued are appropriate for this grade level. In addition, the poem's supernaturally gothic tone provides an array of metaphorical opportunities to help learner's acquire critical reading skills. Finally, Poe's "The Philosophy of Composition," a step-by-step discussion which vividly demonstrates Poe's deliberate word and image choices in "The Raven," provides a unique opportunity for students to explore the author's creative process while simultaneously exploring the creation. The essay, which describes how poets fabricate their work from images selected for consciously determined purposes, serves as a "scaffold" for exploring "The Raven."

Okay. Now the truth. While "The Raven" did, in fact, fit all the above criteria, it would be less than candid not to admit that it also fit nicely into the bookshelf metaphor which a coding approach to the content suggested. One of the instructional goals for this product is that students learn to use external resources for deciphering the multiple meanings of words in a poem. "The Philosophy of Composition" nicely rounded out the bookshelf collection: a dictionary for allowing students to look up words, a biography for allowing students to read about Poe's life, a copy of the essay so student's could learn about the creative process, and the poem itself. Figure 1 depicts one of the screens from this early design.



Click on a book to begin your exploration.

FIGURE 1: The initial interface.

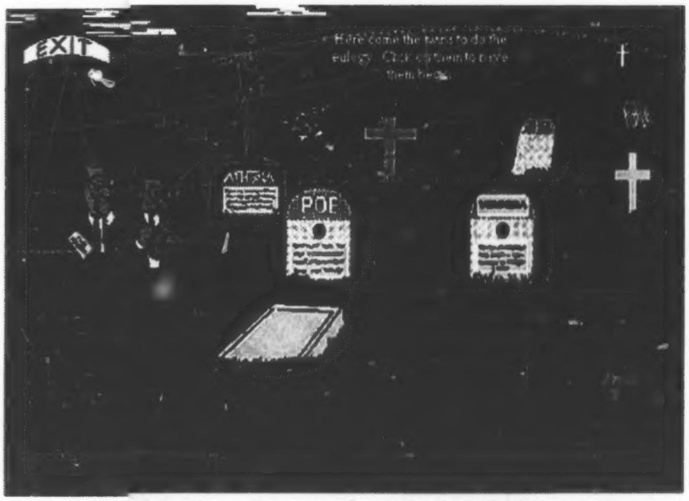
Although this interface is graphical, because it did not represent one thing in terms of something else different, it was in no way metaphorical. This type of design is a Graphical but Non-Metaphorical Interface (GNUI) and is at the lowest end of metaphorical interface design (Cates, 1996). A door is a big wooden thing with a knob on it.

First Attempt to Make the Interface Metaphorical

As Figure 1 shows, in the project's early design, the four resources were represented by the four books on the shelf. The table of contents and bookshelf screens were to be accessible by clicking on miniaturized versions in the navigation strip along the right side of the screen. Navigation functions were represented by the right/left arrow buttons. A map of the entire application was available by clicking on the sign post at the lower left. Although arrow buttons and sign posts have nothing to do with bookshelves, confounding screen devices like these became necessary as it became apparent how difficult this bookshelf interface would be to implement. How would learners pull books off the shelf? Pointing and clicking seemed unnatural. How would pages turn? There are no buttons on real book's pages. How could the program be less passive? With the exception of some workbooks, there is little interactivity with a book. In this way, because of the inadequacy of the bookshelf metaphor, the initial interface quickly moved from a GNUI to a Mixed Metaphorical Graphical User Interface (Mixed MGUI) — one which employs an underlying metaphor, but employs a variety of auxiliary metaphors that are confounding. What the project needed was a stronger primary metaphor.

On the basis of Mac Cormac (1985), Mountford (1990), and Black's (1979) discussions of metaphor operation, one may divide metaphors into two classes: primary (or underlying) metaphors and secondary (or auxiliary) metaphors. A primary metaphor is the principle or first metaphor employed and secondary metaphors is a subsequent metaphor employed by the product (Cates, 1994). The primary metaphor establishes the general context into which the secondary metaphor must fit.

Poe's preoccupation with the macabre and the poem's overriding death theme suggested a cemetery primary metaphor in which learners might explore a variety of objects and characters. A main screen filled with objects and characters upon which the learner clicked might eliminate all need for confounding navigational devices. In addition, if the metaphor were actually *Poe's* fictional funeral, it would be possible to have his ghost deliver excerpts from "The Philosophy of Composition" rather than to make students trudge through its somewhat heavy-handed prose. Having Poe's spirit "speak" directly to the students from the grave about his creative process while they read the poem might help them understand the process better. Twin brothers could eulogize the poet by having one read from the poem while the other added personal anecdotes and interpretations. Figure 2 shows the main screen from this first MGUI attempt.

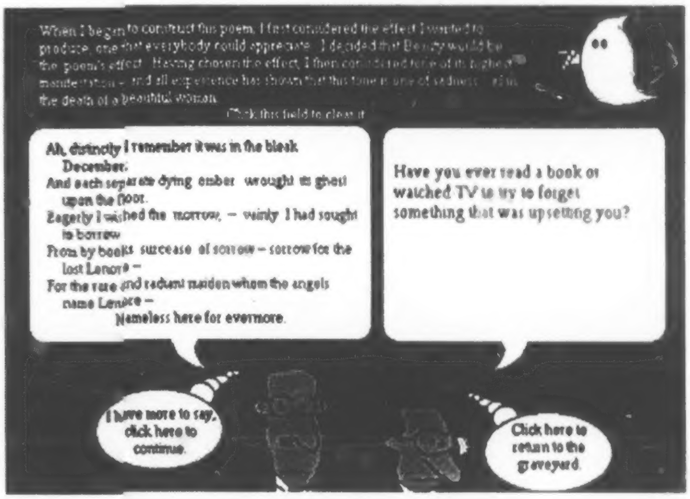


Here come the twins to do the eulogy. Click on them to have them begin.

FIGURE 2: The main screen from the first MGUI attempt.

This screen depicted several objects and characters upon which learners' clicked to "zoom in" and learn pieces of background information about the poem. For example, when learners clicked on Poe's open grave his ghost appeared and briefly outlined the "Philosophy of Composition." When learners clicked on the caretaker, always available to provide help, he gave dynamic suggestions on where to click next. When learners clicked on a tombstone marked "Edgar" their perspective moved in close enough to see its engraving of Poe, his dates of birth and death, and other brief details about his life. When learners clicked on a second tombstone next to Poe's marked "Virginia," his wife described their love and her untimely death. Other objects included a statue of Pallas Athena (Greek goddess of wisdom who briefly described her story and Poe's fascination with "forgotten lore"), a raven in a tree (who said only "Nevermore"), and a suspicious-looking character peering from behind a bush (one of Poe's critics who discussed his views).

After the learner had explored all these objects, the twin mourners arrived to do the eulogy. While they spoke in the "foreground," Poe's ghost occasionally floated through the background dropping roses (taken from the fact that someone leaves a rose at Poe's grave in Baltimore every year on the anniversary of Poe's birthday). When the learner clicked on these roses, the caretaker was replaced by Poe's ghost who provided excerpts from "The Philosophy of Composition" pertinent to the stanza being covered at that time by the twins (see Figure 3).



When I began to construct this poem, I first considered the effect I wanted to produce, one that everybody could appreciate. I decided that Beauty would be the poem's effect. Having chosen the effect, I then considered tone of its highest manifestation – and all experience has shown that this tone is one of sadness [illegible] the death of a beautiful woman.

Click this field to clear it

Ah, distinctly I remember it was in the bleak
December;
And each separate dying ember wrought its ghost
upon the floor.
Eagerly I wished the morrow; – vainly I had sought
to borrow
From by books surcease of sorrow – sorrow for the
lost Lenore –
For the rare and radiant maiden whom the angels
name Lenore –
Nameless here for evermore.

Have you ever read a book or watched TV to try to forget something that was upsetting you?

I have more to say, click here to continue.
Click here to return to the graveyard.

FIGURE 3: The "eulogy" screen.

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The cemetery metaphor lent itself to producing a lesson that was likely to be much more interesting and infinitely more entertaining than the bookshelf version would have been. The primary metaphor had established the general context into which all of the secondary metaphors fit. All of the images used were consonant with the cemetery theme and enhanced the metaphor's believability and efficacy. However, the application was still primarily just a "point-and-click" exercise. Learners using this product were barely more involved in this interface than they would have been with the bookshelf. Consequently, this design fell into the third group on the metaphorical interface design continuum, a Thematic Metaphorical Graphical User Interface (Thematic MGUI — Cates, 1996). A door is a hinged, sliding, or revolving barrier for closing and opening an entrance — with a knob on it. Back to the drawing board.

Implementing an Immersive MGUI

Although thematic GUIs may enhance believability and predictability of the application, they tend to be somewhat flat. In this case, all interaction with the program had become simple back-and-forth navigation zooming in and away from objects on the screen. Moving to the most metaphorical of the graphical user interfaces, the Immersive MGUI, requires adding a third dimension — one that creates an interactive environment for the user. Thus, the first step toward implementing an immersive MGUI was to create a scenario in which the application could become more interactive — by requiring learners to take on the role of the cemetery's caretaker rather than be just passive observers as had been the case in the application's thematic GUI version. In order to get the learners involved in their immersive role as quickly as possible, the application opens with an angry funeral director asking where the learner has been while preparations for the Poe funeral should have been made.

In addition to changes in the scenario, it was necessary to make some other general changes to the interface in order to make it more immersive. For example, to draw learners into the poem's supernaturally gothic tone and increase the interface's three-dimensional feel, grim photographic graphics were chosen to replace the more cartoon-like graphics that had been used in the thematic GUI version. Figure 4 shows the changes that have been made to the main screen.

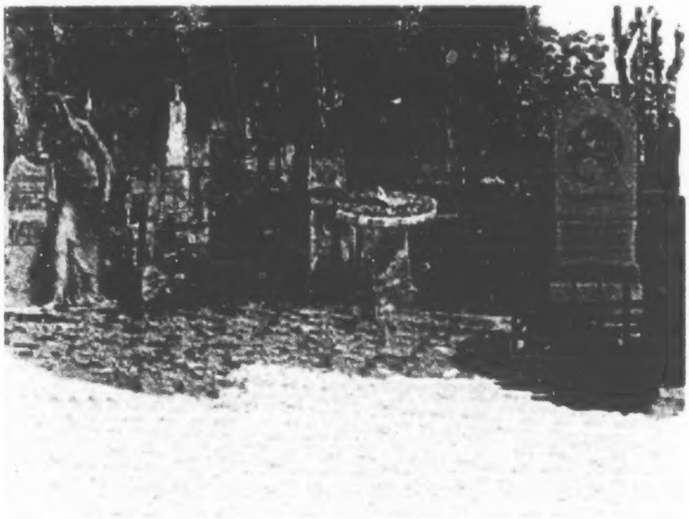

FIGURE 4: Main screen from which all exploration begins.

In addition to setting up the scenario for increased learner involvement, the brooding funeral director enhances the immersive MGUI's foreboding mood by replacing the smiling caretaker that had been a large part of the earlier version.

Three-dimensional objects and enhanced manipulatability are key components of immersive MGUIs. To make "The Funeral of Edgar" interface more interactive, manipulatable objects such as an obituary page, flowers, and charcoal (for stone rubbings) were added. Instead of simply pointing and clicking at these objects, as had been the case with the thematic GUI, objects within the new, more immersive GUI are dragged and dropped. Figure 5 shows a screen in which users learn more about the poet by reading the cards enclosed with flowers left for the deceased.

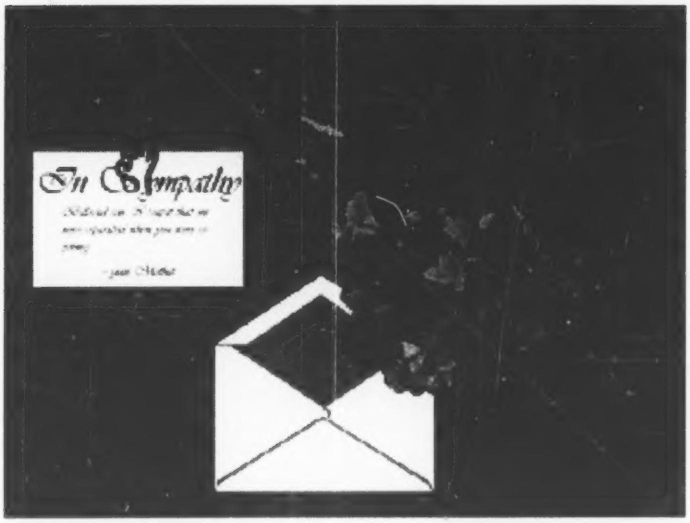

FIGURE 5: Card reading screen.

Rather than simply pointing and clicking on the flowers to get a "blown up" version of the card, learners must actually "pull" the card out of the envelope by dragging it out and dropping it. Changes in the cursor from a "pointer" hand, to a "grabbing" hand, to a "go back" hand enhance the realism of these manipulations and make it possible to navigate while minimizing cumbersome and intrusive mouse clicks (see figures 6-8).

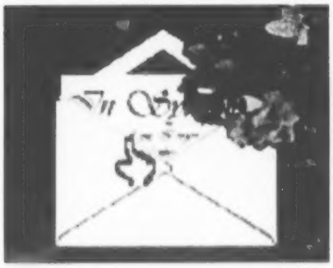

FIGURE 6: Pointer cursor indicates manipulatable object.

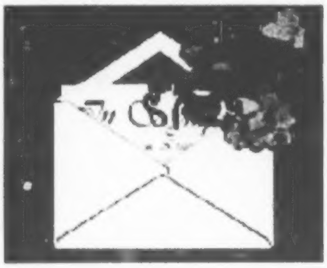

FIGURE 7: Grabbing hand indicates draggable object.

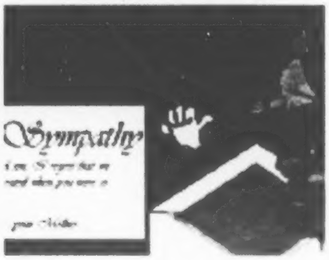

FIGURE 8: "Go back" hand provides means to restore full screen.

To establish the feel of a larger "virtual" world and to eliminate the need for an extensive navigation scheme, the application was programmed so that the screen is literally a small window on an interface that spans three screen widths. When learners click on the left or right side of the screen, the program pans left and right across the interface. Small free-standing directional signs, like the ones which might be found in a cemetery to direct visitors, are positioned in the lower left and right corners of the screen to indicate this functionality.

Cates (1994) suggested that "properties, operations, phrases, images, and types associated with the primary metaphor may provide the imaginal and semantic links" to related, secondary metaphors (p. 3). The primary funeral metaphor lends itself to many secondary metaphors: flowers, mourners, tombstones, graves, epitaphs, caskets, ghosts, eulogies, and seances. These devices are used to provide content- and context-sensitive help, introduce historical background, produce Poe's poetic philosophy, and deliver the poem itself. As before, students gather information pertinent to the poem from the various characters and objects by clicking on them. As learners explore each of these objects, time passes on the sundial eventually triggering events like the arrival of the casket and flowers, the burial ceremony, and the seance. Before exiting the program learners pass through a "field" of grave markers where they see that

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the program has "marked" their place before exiting with an epitaph like "Here lies <student's name>. . . we look forward to his next coming."

Provided one does a good job selecting secondary metaphors, choosing a primary metaphor might appear at first to be a somewhat arbitrary decision. In the thematic MGUI version of "The Funeral of Edgar," the primary cemetery metaphor was generally location-based. Although location-based metaphors may lend themselves to teaching static materials which the learner needs to memorize, the cemetery metaphor left few alternatives for segmenting the complex content that needed to be covered. Consequently, screens like the "eulogy screen" depicted in Figure 3 became overloaded. In contrast, the new version of the lesson relies on a funeral as its primary metaphor; a subtle shift that proved to be a major factor toward making its MGUI more immersive. This change allowed the lesson's content to be metaphorically divided by time: in the period before the funeral learners interact with screen objects to learn background information about the poet and about images used in the poem; during the funeral learners interact with characters to learn more about how differently individuals interpret events; after the funeral students learn that a poem's text includes words that have multiple "layers" of significance to its overall theme.

Concluding Remarks

Thus, "The Funeral of Edgar" evolved slowly from a GNUI to an immersive MGUI in the hope that its audience will feel a greater sense of believability and involvement, which might lead to better comprehension (Cates, 1996). Granted, many 14- to 15-year-old students will not have personal experience with funerals. However, their knowledge of a graveyard's visual, functional, and emotive properties (from television, movies, and books) should be sufficient for the primary and secondary metaphors to operate. In addition, these learners will be familiar with asking others for information (as opposed to consulting reference materials) and with various computer and video games that utilize similar exploration formats.

So, a door is an opportunity and a gate is something you use to get into a cemetery — but don't expect that to be all that there is to it.

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Title:

The Effectiveness of Cooperative Learning for Low- and High-Achieving Students Using an Integrated Learning System

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Abstract

The purpose of this study was to determine whether integrating cooperative learning strategies with ILS-delivered instruction in mathematics produced academic and attitudinal gains in students and, if so, to discern if this strategy was more effective for students with high or low academic ability levels. In order to gauge the efficacy of the intervention, achievement and attitudinal data were collected for all fifth grade students in the selected school prior to the experimental treatment and at the end of the treatment period. Results of this study revealed that students using an ILS for mathematics instruction performed better on standardized tests when they completed the computer activities in cooperative groups. In addition, attitudes and behaviors were more positive towards math and the computer math activities when the students worked in cooperative groups.

In recent years, many schools have turned to Integrated Learning Systems (ILSs) to facilitate instruction and assist with raising state standardized test scores (Becker, 1994). Typically, these ILSs are utilized in a computer lab, where teachers brings their classes into the lab and students work individually on computer-based instructional lessons for an allotted time period. In this model of ILS delivery, students are generally isolated from one another, and are discouraged from sharing information or providing assistance to other students. Although using ILSs in this manner may fit well with the *initial* design and purpose of ILSs (i.e. instruction tailored to individual needs), it has also created problems such as increasing anxiety, hostility, and boredom in students (Lepper, 1985).

Through the integration of cooperative learning with ILS delivery, some of these problems may be alleviated. This study examined achievement and behavior differences between students completing ILS activities in a traditional, individualized format, and students completing the same activities in cooperative learning groups in order to determine if a cooperative learning model could be used effectively with students completing mathematics activities in a lab-based ILS.

THEORETICAL BACKGROUND

Cooperative Learning

Cooperative learning as an instructional strategy for students of varying achievement levels has been widely researched over the past twenty years. In a typical cooperative learning situation, students are grouped together in some manner and asked to work together to complete a task, such as to master some instructional material, develop a report on certain subject matter, or complete a creative project (Lloyd, Crowley, Kohler, & Strain, 1988). Rewards for the individual students within the group are generally based on the accomplishments of the group as a whole. Proponents of cooperative learning argue that having groups of students work together towards a common goal with shared rewards will lead to both academic and social gains for all students participating in the lessons (Johnson & Johnson, 1982; Mesch, Lew, Johnson, & Johnson, 1986).

Researchers have proposed a variety of cooperative learning models in various instructional setting. However, Slavin (1985) has noted that while different cooperative learning models may vary in implementation, they are generally utilizing alternative methods for ensuring that the key elements of cooperative learning are integrated into the instructional task. These key elements of cooperative learning, as outlined by leaders in cooperative learning research such as Johnson and Johnson (1987), and Slavin (1990, 1980), include:

(1) Positive interdependence. Students must believe that each one of them has a key role in the group, and that the task to be accomplished cannot be completed without the actions of each member.

(2) Individual accountability. Each student within a group must be held accountable for mastery of the instruction presented to the group.

(3) Group rewards. There must be sufficient incentives for the group to remain together. The accomplishments of the group as a whole should be rewarded just as the accomplishments of each individual are rewarded.

(4) Group training. Students cannot be placed together in a group situation and be expected to cooperate. As Johnson and Johnson (1987) state, "students must be taught the social skills needed for collaboration, and they must be motivated to use them" (p. 13).

Cooperative Learning's Effects on Achievement

Research examining the academic impact of cooperative learning has provided mostly positive results. Slavin (1983) examined 46 studies in which cooperative learning groups were compared with individual instruction. Of those 46 studies, he found that 29 reported a significant increase in achievement levels for students participating in cooperative learning groups, with another 15 showing no significant differences. Slavin further noted that the studies which did not show learning gains for students in cooperative learning groups did not incorporate one or more of the important components of cooperative learning outlined above. In a second meta-analysis, Slavin (1987) analyzed studies which compared the effects of cooperative learning on achievement with those of students in individual learning situations. Of the 38 studies reviewed, Slavin found that 33 reported significant increases in academic achievement for students participating in cooperative learning situations.

Research has also examined the effectiveness of cooperative learning with students of different academic ability levels. Many proponents of cooperative learning believe that, when implemented properly, cooperative learning is effective for students of all academic ability levels. However, some researchers argue that cooperative learning is not as effective with students of low-ability levels. For example, in a qualitative study by King (1993), third-grade students received mathematics instruction in cooperative groups consisting of two students classified as being high-achieving and two students classified as being low-achieving. Observations of the students working in the cooperative groups revealed that students classified as low-achieving tended to make minimal contributions to the group work and took on passive roles within the group, whereas the students classified as high achieving completed the majority of the group work without input from the other members of the group. This research also noted that "...low achievers were not learning to any significant degree. Lows' self-perceived lack of progress in small groups may indicate that their developing of mathematical understanding and skills is not enhanced by small-group work." (King, 1993, p. 413).

Other research, however, has shown that low-ability students benefit from cooperative learning strategies. In a study by Simsek and Hooper (1992), 30 fifth and sixth grade students worked either independently or cooperatively on a videodisc lesson about whales. The cooperative groups were composed of either one student classified as "low ability" and two students classified as "high ability," or two students classified as "low ability" and one student classified as "high ability." Posttest results revealed that students participating in cooperative groups, regardless of ability level, scored significantly higher. Similar positive effects of cooperative learning with students of varying ability levels were discussed by Hooper (1992), Watson and Rangel (1989), Slavin (1991), and Johnson and Johnson (1992).

Cooperative Learning's Effects on Student Attitudes and Social Behaviors

Research shows that cooperative learning can have a positive impact on students' social behaviors and attitudes towards instructional content. In a study by Farivar (1992), seventh-grade students worked on mathematics assignments in cooperative groups. Results of the study indicated improved attitudes towards both cooperative learning activities and mathematics in general. Good, Reys, Grouws, and Mulryan (1989-1990) found that cooperative group work in mathematics increased students' motivation and enthusiasm towards the subject matter. Similar findings were reported by Davidson and Kroll (1991) and Slavin (1985).

In terms of effects on social behaviors, Mesch, Lew, Johnson, and Johnson (1986) placed students in cooperative learning situations and provided them with training on effectively interacting in those situations. As a result of the training and cooperative group experiences, these researchers found that students who tended to be isolated and withdrawn interacted significantly more with their peers both within and outside the cooperative learning activities. In a meta-analysis of five studies dealing with cooperative learning, Lloyd, Crowley, Kohler, and Strain (1988) concluded that cooperative learning had significant positive effects, "particularly on social behavior, in comparison to competitive and individualistic procedures." (p. 43). Several studies have found that cooperative learning improves relationships between disabled and non-disabled peers (Armstrong, Johnson, & Balow, 1981; Madden & Slavin, 1983; Yager, Johnson, Johnson, & Snider, 1985), and between students from different ethnic and racial backgrounds (Slavin, 1983). Research has also shown cooperative learning to decrease behavior difficulties such as talking out and not paying attention in the classroom (Greenwood, Carta, & Hall, 1988; Mulryan, 1995; Tyrrell, 1990).

Integrating Cooperative Learning with Computer-Assisted-Instruction and ILSs

As interest in applying cooperative learning in a wider variety of instructional settings has grown, there has been an increase in research investigating integration of cooperative learning with other instructional tools. One such combination is cooperative learning and computer-assisted-instruction (CAI). Some have argued that, by providing students with peer support and assistance when utilizing traditionally individualized tools such as CAI, cooperative learning can increase the effectiveness those tools have on student achievement (Becker, 1992). For example, Mevarech, Stern, and Levita (1987) placed junior high school students into cooperative learning groups and asked the groups to complete language arts CAI lessons. Results indicated that students who worked on the CAI lessons in cooperative groups demonstrated significantly greater academic gains than their peers working on the CAI lessons individually. Similar positive results when combining cooperative learning and CAI were found by Hooper and Hannafin (1991), and

Hooper, Temiyakarn, and Williams (1993). In these studies, peer interactions, positive student attitudes towards the group activities, and the construction of a supportive learning environment were all determined to be factors which contributed to positive academic gains for students.

In the past few years, CAI has evolved into powerful and costly systems, such as ILSs (Wiburg, 1995). An ILS is generally implemented in a computer lab of 15 to 30 computers linked to a central fileserver. The fileserver contains instructional software which contains entire curricula in reading, writing, mathematics, science, or other disciplines, over several grade levels (Bender, 1991; Robinson, 1991). This software is individually distributed to each computer in the computer lab, so that each student using the lab can work on any lesson at any given time. With this system, teachers (or students) can simply select the lessons they wish to use by choosing from a menu, or they can allow the computer to determine the appropriate content and difficulty level for particular students. In the latter case, the ILS selects and assigns lessons which either introduce new concepts or provide remediation of more difficult concepts according to the needs of each student. The ILS can also maintain detailed records of each student's progress and performance which the teacher can access at any time for assessment and evaluation purposes.

The research dealing with the academic effectiveness of combining cooperative learning with ILS-delivered instruction is somewhat limited. Mevarech (1994) investigated the impact of using a cooperative versus individual model when using an ILS system developed in Israel. Results of this study indicated that students working in cooperative groups performed significantly better on tests of both mathematics basic skills and higher-level concepts than their peers working individually.

Knowledge about the effectiveness of integrating ILSs and cooperative learning could prove invaluable to teachers and administrators who are struggling to incorporate ILS instruction into their curriculum. The large cost of establishing and maintaining such systems, coupled with limited resources, force many school districts to target specific students to use ILS resources (Becker, 1994). This becomes necessary when schools do not have the facilities to serve all students. If cooperative learning in an ILS setting were shown to be effective, not only will students benefit from an academic and social learning perspective, but school districts will be able to utilize their ILS resources more efficiently by serving more students.

The purpose of this study was to determine whether integrating cooperative learning strategies with ILS-delivered instruction produced positive academic and attitudinal gains in students. In addition, this study examined the effectiveness of combining ILS and cooperative learning with students of different academic ability levels. Student achievement test data, results from an attitudinal questionnaire, and researcher observations of student behavior were used to determine significant differences between the treatment groups.

METHOD

Subjects and Setting

The subjects were 65 fifth grade students in one selected elementary school located in a small city in the upper midwest. The school selected for the study was the second-largest of the three elementary schools in the school district, with an overall enrollment of approximately 520 students. The teacher/ student ratio for the selected school was approximately 1:20, with an average class size of 25 students.

The children enrolled in the school were generally from households with low to lower-middle socioeconomic status, and the average income of families served by the school was approximately $12,000. As a result of the low socioeconomic levels in the community, approximately 43% of the students served by this school were eligible for free or reduced lunches under federal guidelines. The school also served children whose parents were military personnel, which accounted for approximately 20% of the total student population. The ethnic distribution of the students was approximately 60% Caucasian, 30% African-American, and 10% from other ethnic groups.

Initially, 71 students were eligible to participate in the study by virtue of their enrollment in one of the three fifth-grade classrooms at the school. However, two students left the district during the second week of school, two students left school immediately after completing the pre-tests, and parental consent was not received from two other students. One new student enrolled in the school during the fifth week of the study, but was not included in data collection. Thus, a total of 65 students participated in the study. The ethnic breakdown of the students participating was 70% Caucasian, 25% African-American, and 5% Asian-American. Thirty-seven percent of the students were female, and 63% were male.

Students participating in this study had already used the ILS labs and the computerized mathematics curriculum for a year, so training on use of the computer was not necessary. Any students new to the district received an orientation to the ILS lab as mandated by school computer-use policies.

Design and Materials

This study used a 2 X 2 (treatment group X ability level) posttest-only design to determine achievement differences. All subjects were blocked by ability based on pretest scores. The dependent variable was mathematics achievement. This variable was operationally defined as the achievement test post-test scores.

Since intact classes were used in assigning students to treatments, the difference in group pretest scores could not be fully accounted for experimentally. The pretest mean of students in the control group (M = 45.95) was somewhat higher than the mean of the students in the experimental group (M = 45.07). This difference in pretest means was not significant, $F(1,64) = 0.88$, $p = .352$, however, owing to the importance of student ability in the present study posttest data were analyzed using an analysis of covariance (ANCOVA) with student pretest scores as the covariate. The ANCOVA procedure is recommended by Taylor and Innocenti (1993) to increase statistical power.

To determine attitudinal differences between the treatment groups, separate chi-squares were calculated using the student responses obtained for each of the attitudinal questions on the student exit questionnaire.

Testing Instrument - The California Achievement Test, Fifth Edition (CAT/5), was used as both the pre- and post-test instrument for mathematics achievement. For this study, students completed parallel forms of Level 15 of the entire mathematics battery (Form A for the pre-test and Form B for the post-test). Level 15 is the grade 5 level of the test (grade range 4.6 - 6.2). Both versions of the test consisted of 94 questions, 44 of which pertained to math computation and 50 to math concepts and applications. The mathematics computation portion of the test covered traditional computation operations such as whole numbers, decimals, fractions, integers, percents, algebraic expressions, estimation and using hand-held calculators. The mathematics concepts and applications portion focused on problem solving, which includes the "...broad range of strategies and critical-thinking skills students use in confronting problems based in any area of mathematics." (CTB/Macmillan/McGraw-Hill, 1992, p.9).

Level 15 of the mathematics section of the test has a standardized mean of 58.38, a standard deviation of 18.00, and a standard error of measurement of 4.01. Split-half reliability of the test, as measured by the Kuder-Richardson Formula 20 measure of internal consistency was 0.95 (CTB/Macmillan/McGraw-Hill, 1992).

Curriculum - The Jostens mathematics curriculum was used as the instructional content. This curriculum covered the entire range of the 5th grade curricular objectives for mathematics for the state of Michigan, as outlined by the Michigan Essential Goals and Objectives for Mathematics (Jostens Learning Corporation, 1990). The mathematical concepts covered in these objectives for grade five include whole numbers and numeration; fractions, decimals, ratios, and percents; measurement; geometry; statistics and probability; algebraic ideas; problem solving and logical reasoning; and calculators. These concepts also corresponded to the objectives covered on the California Achievement Test (Jostens Learning Corporation, 1993).

Delivery - The instruction was delivered via a networked ILS lab, with 30 computer stations in the lab. With this delivery method, each student (or pair of students) received mathematics lessons as determined by their performance and progress.

Training Documents - Training materials and activities were developed to assist students with establishing their cooperative groups, and to help students understand their roles and responsibilities as members of groups. There were two separate cooperative activities used to provide training in cooperative learning strategies, one domain-general and the other domain-specific. The domain-general activity provided students with an opportunity to work together to complete a task that was not related to any particular content area. The second activity specifically dealt with mathematics concepts.

Student Exit Questionnaire - A student exit questionnaire was developed by the researcher and administered to participating students during the last week of the study. There were seven questions on the survey, asking students about their attitudes regarding math, the computer math lessons, and group activities. The survey was reviewed and approved by a group of education experts prior to administering the survey to students.

Procedure

At the beginning of the third week of school, the classroom teachers administered the pre-test to the students participating in the study. The test took two days to complete. Students completed the first part of the pre-test (computation) on the first day and the second part of the pre-test (concepts and applications) on the second day. Each student completed the pre-test individually.

Students scoring below the group median for the pretest were classified "low-achieving," students scoring at or above the median were classified as "high-achieving." This provided 32 students in the low-achieving group and 33 students in the high-achieving group. Students in one of the three fifth grade classes were randomly assigned to the individual learning (control) group, and students in the other two classes were assigned to the cooperative (experimental) group.

For the two experimental classes, each student was randomly paired with another student in their class. Thus, since there were 44 students in the experimental classes, a total of 22 cooperative groups were formed. These student pairs then received training on cooperative learning and group interaction. All student teams completed the training prior to starting their work on the computers. The 21 students in the control class did not receive any training.

At the beginning of the fourth week of school, all students participating in the study started working on the computer lessons. Students in the experimental group worked on the lessons with their partners, while students in the control group worked individually on the lessons. Students worked on the computer math lessons one time a week for 50 minutes each session. Students in the experimental group worked with their partners for the entire 50 minutes. The classroom teacher and lab assistant were present in the lab during each session.

Students in both the experimental group and the control group were observed by the researcher during their mathematics lab time each week throughout the study. The purpose of the observations was to collect anecdotal and qualitative data regarding student actions and work habits in the computer lab. The researcher observed for 30 of the 50 minutes of each session, allowing the first 10 minutes for students to move to their assigned seats, log in, and begin working, and the last 10 minutes for students to print their results and save their work.

The researcher used a pre-developed observation form to record any student comments or questions towards the teacher or lab assistant, student comments to themselves or their partners, and the frequency with which each student or group requested assistance from the teacher or lab assistant. In collecting these data, the researcher observed from an unobtrusive location in the computer lab. The researcher never interacted with the students during observations. Occasionally, the researcher would ask the teacher or lab assistant for clarification on interactions that took place. The researcher met with the computer lab assistant at the end of each week to discuss potential interaction problems with the student pairs, and to obtain feedback regarding the performance of the students in the lab.

All students participating in the study were also asked to complete attitudinal questionnaires during the final week of the study. The questionnaire asked students questions dealing with their attitudes towards mathematics, the computer math lessons, and working in cooperative groups. The questionnaires were administered to the students in the computer lab by the lab assistant.

Students in the study worked on computerized math lessons once a week for a period of 11 weeks. At the end of the treatment period, the students participating in the study were given a post-test using the mathematics portion of form B of the CAT/5. The protocol for administration of the post-test was identical to that of the pre-test. As with the pre-test, each student completed the post-test individually.

RESULTS

Achievement Test Data

A summary of posttest means and adjusted means is provided in Table 1. Student pretest results showed no significant differences between the experimental group and the control group.

Table 1.
Mean Adjusted Posttest Scores for Achievement Tests by Group and Achievement Level.

Group	Achievement Level		
	Low	High	Total
Experimental			
M	56.10	51.61	53.75
Unadj. Mean	43.71	62.17	53.36
Control			
M	48.50	49.67	49.14
Unadj. Mean	40.18	59.80	49.52

The adjusted mean for students in the experimental group (M = 53.75) was significantly higher than the adjusted mean for students in the control group (M = 49.14), F(1,64) = 4.76, p < .05 (see Figure 1). The group X ability level interaction effect showed the greatest disparity of scores between the low-ability students in the experimental group and low-ability students in the control group. The adjusted mean for students in the experimental/low-ability group was 56.10, whereas the adjusted mean for students in the control/low-ability group was 48.50 (see Figure 2). However, this difference was not significant, F(1,64) = 1.67, p = .20.

Figure 1.
Adjusted Posttest Scores by Group.

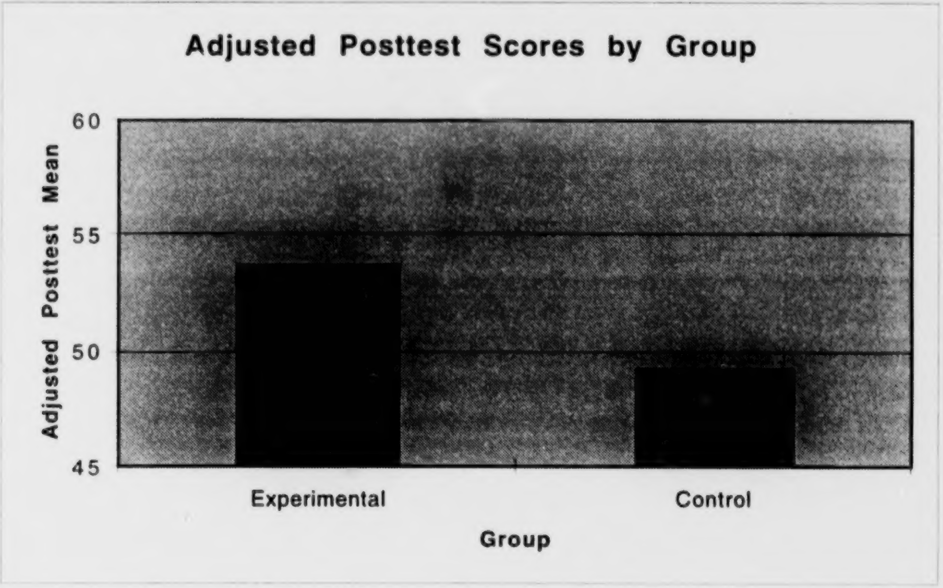
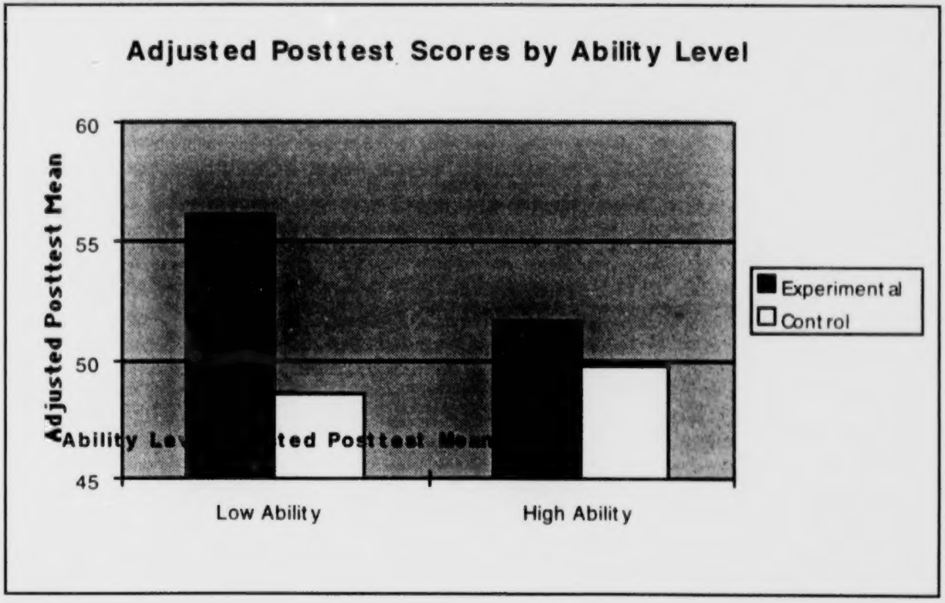


Figure 2.
Adjusted Posttest Scores by Ability Level.



Questionnaire Results

Responses to the questionnaire revealed attitudinal differences between students in the control group and students in the experimental group, particularly in terms of attitudes towards math and the computer math lessons. Refer to Table 2 for a summary of the questionnaire results.

Table 2.
Student Exit Questionnaire Results.

Questionnaire Statement	Student Responses	
	Experimental	Control
1. Do you like math?	Yes = 91%	Yes = 57%
2. Do you think you do well in math?	Yes = 86%	Yes = 76%
3. Do you like the computer math lessons?	Yes = 94%	Yes = 43%
4. Do the computer math lessons help you with your math classwork?	Yes = 85%	Yes = 62%
5. Do the computer math lessons help you with your math homework?	Yes = 73%	Yes = 48%
6. Would you rather work on the math lessons alone or with a partner?	Partner = 68%	Partner = 76%

On the statement dealing with math attitudes (question 1), 91% of the students in the experimental group responded that they liked math, as opposed to 57% in the control group. A chi square test of these data revealed significant differences, $\chi 2$ (1, $\underline{N}$ = 65) = 10.13, $\underline{p} < .002$.

In terms of the computer math lessons (question 3), 94% of the students in the experimental group responded that they liked the computer math lessons, as opposed to only 43% in the control group. Once again, a chi square test revealed significant differences, $\chi 2$ (1, $\underline{N}$ = 65) = 20.28, $\underline{p} < .001$.

In addition, students in the experimental group responded significantly more favorably than students in the control group when asked if they believed the computer math lessons helped them with their math classwork and homework. Eighty-five percent of the students in the experimental group responded that they believed the computer math lessons helped them with their math classwork (question 4), as opposed to 62% of the students in the control group, $\chi 2$ (1, $\underline{N}$ = 65) = 3.94, $\underline{p} < .05$. Seventy-three percent of the students in the experimental group responded that they believed the computer math lessons helped them with their math homework (question 5), compared to 48% of the students in the control group, $\chi 2$ (1, $\underline{N}$ = 65) = 3.92, $\underline{p} < .05$.

On the questionnaire statement dealing with working with a partner (question 6), 76% of the students in the control group stated that they would rather work on the computer with a partner, as opposed to 68% in the experimental group. These data were not statistically significant, however.

The attitudinal data were also analyzed using student ability level as a blocking variable. This analysis revealed no additional significant differences between the groups.

Computer Lab Observations

During each computer lab observation, the researcher recorded verbal comments made by students to other students, the teacher or lab assistant, or themselves. Comments recorded for students in the experimental group dealt mainly with group interactions. Examples of some of the comments recorded included phrases such as: "Do you agree? ", "If you're only watching me you're not going to learn!", "Pay attention!", "You do this one.", "Don't ask for help yet.", and "We've got to take turns!". In addition, the researcher noted that many of the questions asked by students in the experimental group dealt with the content in the computer math lessons (e.g., "We don't understand this problem.", "Do we need to add or multiply here?").

The comments made by students in the control group dealt mainly with students' frustration with the computer math lessons. A sample of some of their statements included: "Can I get a sledgehammer?", "I'm getting tired of this junk!", "I want to go home.", "I don't know and I don't care!", "I hate math.", "What time do we leave?", and "I'm stupid!".

In addition to recording students' comments, the researcher also collected anecdotal data regarding interactions between students working in cooperative groups, on-task and off-task behaviors exhibited by students, and interactions between students and the teacher or lab assistant. The researcher observed that students in the experimental group demonstrated behaviors designed to monitor each other and keep each other on task. For example, if one of the students in a cooperative group was not paying attention, the other student in the group would gain the student's attention, either through a verbal comment or a tactile cue (such as pulling on their shirt), and would re-engage them in the lesson. In this way, the members of the groups were observed assisting each other in remaining on-task and engaged in the instructional content.

Analysis of observational data of students in the control group revealed a different set of behaviors than those in the experimental group. Students in the control group repeatedly demonstrated off-task behaviors such as putting their heads down on the table and giving up, quitting out of the lessons before they were finished to work on writing or drawing activities, staring out the window, asking to go to the bathroom or go get a drink, and "guessing" on math activities just to get through the lessons. These types of behaviors were generally not exhibited by students in the experimental group. The lab assistant was repeatedly overheard explaining to students that they needed to ask for help when they were stuck on a problem, and not give up. It was apparent that some students in the control group had difficulty knowing when to ask for help.

DISCUSSION

The notion of combining ILS-delivered instruction with cooperative learning activities has not been widely studied. This research has shown that integrating cooperative learning with ILS-delivered instruction is an effective instructional strategy. Results of this study showed that students working on math activities delivered by an ILS performed better on tests of those activities when they completed the activities in cooperative pairs than when they worked on the activities individually. In addition, this study showed that combining a cooperative learning model with ILS instruction had a positive impact on student attitudes towards the instructional content.

There are a number of possible reasons for the significant achievement differences between the experimental group and the control group. One explanation is that students working in pairs were able to assist one another with the computer math activities, thus creating peer support structures within their groups (Mevarech, 1994). If one student in the pair did not understand the math concept being presented, the other student had the opportunity to explain the concept. Through this dialog, not only did students who did not understand the concepts receive additional instruction from their partners, but their partners may have been able to reinforce their own understanding of the concepts through explanation. If students working individually did not understand any of the concepts being presented, the alternatives were to either guess at the answer or ask the teacher or lab attendant for assistance. If they chose to ask for assistance, they generally had to wait for the teacher to finish helping another student, thus decreasing their on-task time further. If they chose to guess, then it was likely that they did not understand the concept and would have more difficulty understanding future concepts.

A second explanation is that students working in pairs tended to stay on task while working on the lessons, whereas students working individually were more likely to either be distracted from the math activities or stop working altogether. During computer lab observations, the researcher recorded that students in the control group demonstrated off-task behaviors such as putting their heads down on the desk or staring out the window. These behaviors were not observed in the experimental classes. By staying focused on the computer math lessons and engaged in the content of the lessons, students in the experimental group most likely learned more math concepts, and thus were able to perform better on the math achievement test.

Finally, it is likely that teachers were able to spend more time with and provide a higher quality of assistance to students working in cooperative groups than students working individually. Even though there were about the same number of students in each of the classes participating in the study, teachers for the experimental group classes had an easier time getting around to all the students that needed assistance. This is because (1) in the experimental classes, teachers could work with two students at the same time, whereas in the control class the teacher had to work with each student individually, and (2) there were fewer off-task behavior problems that required teacher intervention in the experimental classes. Thus, pairing of students allowed the teacher to spend more time with the students who needed help and thus provide a greater amount of small-group tutoring on difficult concepts. This may have been particularly effective for low-achieving students, who had a greater need for teacher intervention and guidance than high-achieving students.

Results of this study also demonstrated significant differences in attitudes towards both the content and the delivery system. As with the achievement results, a major contributor to the positive attitudes reported by students working in cooperative groups could be the support structure provided by the cooperative groups. Students working individually on the lessons were observed getting frustrated and upset with the computer math activities, whereas students working on the lessons in cooperative groups were observed helping one another stay focused on the activities. Without the availability of peer assistance, students in the control group had to struggle through the lessons alone. This isolation from their peers may have contributed to their dislike of the lessons and of math in general. Also, students in the control group possibly did not receive as much teacher support in the computer lab when they were having difficulty with the math activities, thus exacerbating their frustration and contributing to their lack of success in the lab. It is logical to assume that students would have negative attitudes towards activities in which they were not succeeding.

Limitations

Readers should be careful when interpreting the results of this study, and to take into account the following limitations which may have impact on the internal and external validity of these results:

1. Subjects and sample size - only fifth-grade students from one elementary school participated in this study. It may be difficult to generalize these results to other age-groups. For example, younger students may have had more difficulty interacting and staying on-task in cooperative group activities. In addition, only 65 students participated in this study. The researcher concedes that the results may have been more significant with a larger population participating, due to larger sub-groups and the increase in statistical power associated with a larger population.

2. Subject-matter - mathematics was used as the content area for this study. These results may not necessarily transfer to other subject areas such as language arts, science, or social studies. Writing activities, for example, generally take longer to complete than math problems and students may have more difficulty completing this type of activity in cooperative groups due to the personal nature of many writing activities.

3. Teaching styles - readers should be reminded that the control group consisted of all the students in one particular fifth-grade class, and that the experimental group consisted of students in two fifth-grade classes. The researcher concedes that this method of dividing the experimental group and the control group is not as experimentally sound as a true random dispersion of students due to confounding variables (such as the teacher) that could not be controlled. However, due to ethical considerations, the researcher felt that the method chosen was the best way of dividing the students. Students in each of the participating classrooms did not have the same teachers for math instruction. Thus, it was inevitable that different teaching styles, discipline strategies, and instructional methods would be used in the different classrooms. These differences in teaching styles during computer lab time most likely had some impact on the results of this study. Readers should take this into account when generalizing these results.

Conclusion

Research investigating both integrated learning systems and cooperative learning has shown them to have positive effects on academic achievement levels and attitudes of students. This study has revealed that combining an ILS delivery system with cooperative learning strategies can also facilitate the learning process.

There are several considerations that should be taken into account when combining cooperative learning and integrated learning systems. First, a learning area conducive to cooperative learning activities is important, particularly in a computer lab setting. Students need to be able to easily work together in their group without feeling cramped, and groups need to be separated from one another so that they do not distract each other. Second, teacher support in the computer lab is key to the successful combination of cooperative learning and ILS. Cooperative learning provides teachers with the opportunity to spend more time tutoring small groups of students. However, teachers need to take an active instructional role in the computer lab in order for this strategy to have the greatest impact on students. Teachers who take a passive, reactive role in the computer lab will most likely see that cooperative learning and ILS provides fewer positive academic benefits to their students. Finally, the activities students are completing using the ILS, whether those activities are completed in cooperative groups or individually, need to correspond to the concepts being taught in the classroom. If students learn new concepts in the computer lab, and those concepts are not reinforced in the classroom, then students will have difficulty remembering those concepts. Teachers need to use the instructional activities provided through the ILS to enhance and support their curriculum. Keeping classroom activities and computer lab activities separate and distinct will diminish the effectiveness of the instruction provided in both settings.

The results of this study suggest to educators that using cooperative learning strategies in a computer lab setting can have greater benefits than increased standardized achievement test scores. Although test results did reveal significant differences between the experimental group and the control group, the differences between the groups were greater than those measured by a test. Student behaviors appeared to be markedly different, and the enjoyment and excitement observed in the experimental classes was not as noticeable in the control class. These behavior differences should encourage educators to look beyond simple test scores in order to determine the full merits of this strategy.

This study provides evidence that an instructional strategy that research has demonstrated as effective with different populations of students can be effectively integrated into a ILS lab setting. Based on these results, educators may want to consider experimenting with the use of other instructional strategies in ILS labs. Combining different strategies with ILS instruction will definitely be more effective then continuing to use ILS labs as reinforcement tools or as instruments to passively feed instruction to students. An integrated learning system is a powerful tool in its own right when used properly. Utilizing effective instructional strategies such as cooperative learning with an ILS can make that tool even more powerful.

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Title:

Towards A Taxonomy Of Metaphorical Graphical User Interfaces: Demands And Implementations

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The Graphical User Interface (GUI) has become something of a standard for instructional programs in recent years. Not all graphical programs' interfaces, however, implement the GUI in the same way. Some are more graphical than others and some employ a more unified approach than others. One type of graphical user interface is the metaphorical GUI. A metaphorical GUI bases its look and feel, as well as many of its operations, on an explicit or implicit metaphor. For example, the Macintosh GUI is based on the "desktop" metaphor; objects one manipulates within the GUI are implied to be objects one might well find on a real office's desktop.

Cates (1994) divided metaphors into two classes: *underlying* (or *primary*) metaphors and *auxiliary* (or *secondary*) metaphors. The underlying metaphor is the principal metaphor employed or, by default, the first metaphor introduced, while an auxiliary metaphor is a subsequent metaphor employed by the product. The underlying metaphor establishes the implied comparison and the basic framework for the interface. Auxiliary metaphors may be either *complementary* or *confounding*. Complementary auxiliary metaphors add to, enhance, and help complete the underlying metaphor. They exhibit high degrees of affinity and acceptable levels of contrast in relation to the underlying metaphor (Kittay, 1987) and they operate in ways that match the experiences of users working with the object to which the designer is comparing the product's interface (the underlying metaphor). When contrast occurs, it is of the type that encourages users to reinterpret and reconstruct their understanding of how the interface operates (Miller, 1979; Searle, 1979). A confounding auxiliary metaphor is one in which the user finds the contrast too great and rejects the comparison (Semper, 1990).

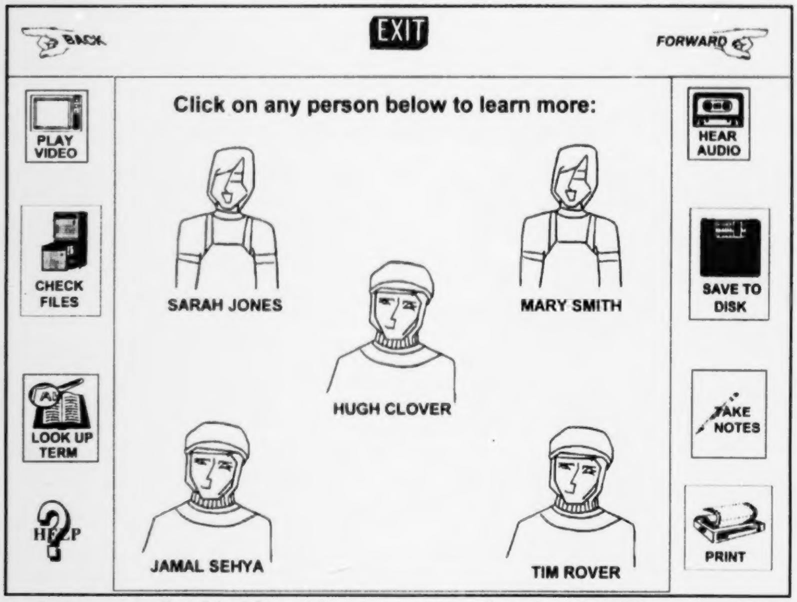
Once again using the Mac's operating system as the basis for discussion, the underlying metaphor is the "desktop." The main auxiliary metaphors are the document, the folder, and the trash can. Documents — represented by icons that look like papers — and folders are clearly objects one might find on a desktop and are complementary auxiliary metaphors, therefore. In contrast, however, the trash can auxiliary metaphor would need to be classified as confounding. While one might well expect to find a trash can in an office, it is both illogical and inconsistent — although convenient — for the trash can to reside on top of the desk (Vertelney, Arent, & Lieberman, 1990).

Not all objects or images that appear in a graphical user interface are guaranteed to be metaphorical, however. For example, once again in the Mac interface, while a computer hard disk (represented in the interface by a labeled icon of a hard drive) is clearly an object that might appear on a desktop, it is in no way metaphorical. The same is true for floppy disks (represented similarly by labeled iconic representations on the desktop). That is, in order for something to be metaphorical, it must represent one thing in terms of something else different (Black, 1979; Lakoff & Johnson, 1980). In addition, interfaces sometimes employ graphical images that are purely symbolic. For example, the Mac interface displays what appears to be a teddy bear's head attached to a 3.5" diskette "body" to represent the Fetch™ program. While the interface designers at Apple cannot be blamed for non-metaphorical program icons, there is reason to be concerned that non-metaphorical icons may serve to "break the spell" of the underlying metaphor, thus reducing the user to a non-systematic evaluation of what he or she sees on a case-by-case basis (Cates, 1993). When the spell is broken, the user no longer seems likely to benefit from the augmentative properties of metaphorical interface design that Rosendahl-Kreitman (1990) has suggested add so much to the experience of using the program. In a graphical user interface, metaphorical images can help users make linkages between their imaginal and semantic networks (Paivio, 1971, 1979, 1986), thereby creating the webs of association that help to take advantage of learners' mental models and previous experiences (Erickson, 1990; Mac Cormac, 1985).

Cates (1993) offered a three-level (superficial-literal-interpretive) model for evaluating the metaphorical promise of icons. That paper emphasized the relationship between visual images and metaphors in terms of the ways users understand and interpret interfaces. Cates (1994) suggested that designers use the five-part POPIT (properties, operations, phrases, images, and types) model to identify imaginal and semantic links and thus, complementary auxiliary metaphors. The present paper attempts to classify metaphorical interfaces along a four-point continuum from lowest level of metaphorical implementation to highest, from non-metaphorical to immersive. It explores how position on that continuum exemplifies the interaction between complementary and confounding auxiliary metaphors and determines the design demands of an interface. Along the way, we will consider how the same basic metaphor may be implemented differently to meet these demands.

Graphical But Non-Metaphorical User Interfaces (GNUI)

This position on the continuum equates with the null or end-stop position. That is, it is included here merely to indicate where metaphorical GUIs end. A GNUI is an interface that employs images and asks the user to perform actions using graphical images, but employs no underlying metaphor. That is, the user is not asked to compare what he or she is doing to actions in some other situation, setting, or condition.



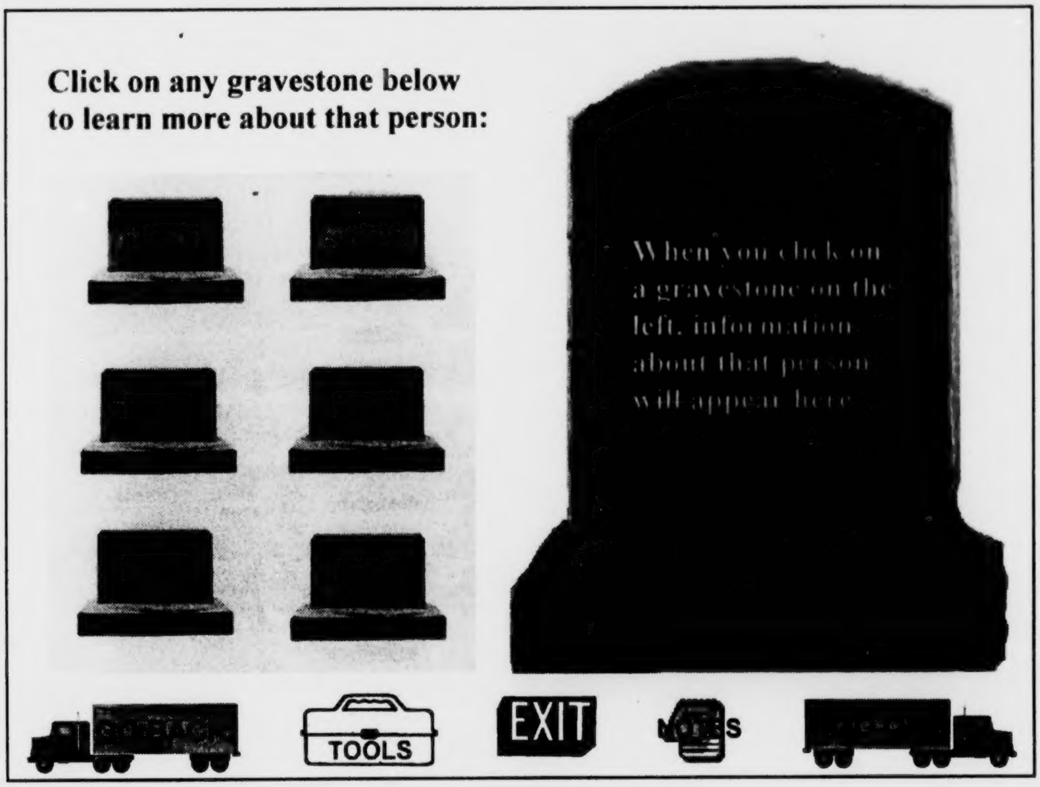
Click on any person below to learn more:

Figure 6: A sample Graphical Non-Metaphorical User Interface (GNUI).

For instance, figure 1 shows a possible GNUI implementation of a history lesson on biography and being remembered. As the figure shows, five figures to be examined are represented by abstract (cartoon) drawings. Navigation functions are represented by pointing fingers and an exit sign. While these have some minor metaphoric properties, in the absence of an underlying metaphor, these properties will most probably go unnoticed by users. The television screen, audio cassette tape, filing cabinet, and diskette are clearly visual representations of the objects themselves, not metaphors. The same is true of the pencil and printer. One might try to read something metaphoric into the glossary function and the help function here, but once again, in the absence of an underlying metaphor, these icons are primarily graphical or representational.

Mixed Metaphorical Graphical User Interface (Mixed MGUI)

A Mixed MGUI would employ an underlying metaphor, but would then employ a variety of auxiliary metaphors that were confounding. Figure 2 shows such a Mixed MGUI.



Click on any gravestone below to learn more about that person:

When you click on a gravestone on the left, information about that person will appear here.

Figure 2: A sample Mixed Metaphorical Graphical User Interface.

Notice in the figure that the underlying metaphor is of a cemetery, although the metaphor is more implied than explicit, since we do not see the entire cemetery at any point. The gravestones are certainly consonant with the cemetery metaphor. Trucks for navigation and a lighted exit sign are not, however. It is unclear how a notebook or a toolbox complements the metaphor, although one might envision ways to make them consonant. This is part of the reinterpretative process that users perform in order to make metaphorical images fit (Miller, 1979). The designer has asked them, however, to make a bit of a stretch. One might think of this as stretching credibility. That is, as the user sees more images that exhibit high levels of dissonance, he or she begins to wonder whether the metaphor is appropriate. Once users reject the metaphor, they begin to think of images on the screen as devices only, not elements in a larger system that permit the user to infer and construct new understandings based on logical extensions of the metaphor itself. While images and icons of toolboxes, notebooks, and exit signs might represent reasonable auxiliary metaphors for the operations they provide or empower, in this case they clearly do not complement the underlying metaphor.

Another variation on the Mixed MGUI is an interface in which there is an underlying metaphor and some complementary auxiliary metaphors, but some images are non-metaphorical or represent confounding auxiliary metaphors. For instance, by added images of a printer, a computer disk, and other similar devices to the images in Figure 2, we could confound the metaphor further. Even if, at the same time, we added additional complementary auxiliary metaphors, it seems likely that users would be inclined to reject the underlying metaphor, defaulting instead to seeing everything on the screen as a device. In fact, the presence of non-metaphorical images seems likely to encourage them to view screen images as simply devices.

Still another variation on the Mixed MGUI is one in which the designer has employed more than one underlying metaphor, accompanied by —or resulting in— confounding auxiliary metaphors. Thus, when the user goes to certain portions of the program, the underlying metaphor changes. For instance, imagine that the initial underlying metaphor

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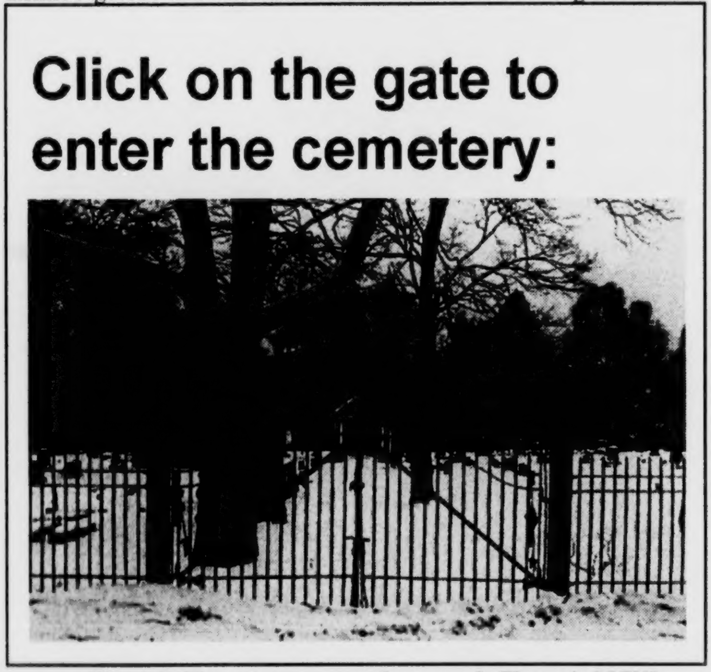
were of a cemetery accompanied by complementary auxiliary metaphors. When the user clicks on some image, he or she is sent to a music store to listen to music that is in some way related. In effect, the underlying metaphor has changed; a music store is not a cemetery. Consider what would happen if the designer retained some or all of the same icons provided when the underlying metaphor was of a cemetery. Since the complementary metaphors for a cemetery are likely to be confounding metaphors in a music store, we would say that the designer had mixed metaphors.

There are too few clearly explicated examples in the field of interface design and many of the examples available are not as useful or well designed as they might be (Mountford, 1990). It is often easier to focus on simple graphics and pleasing layout than on making the metaphor work. In fact, Nelson (1990) suggested that an overdependence on metaphor can ruin an otherwise good design. At the same time, making the most of a metaphor may enable designers to imply more than they state and may help users comprehend without having to tell them all details (Andre & Phye, 1986). The absence of adequate explication and the paucity of strong examples may explain why so many designers' GUIs suffer from the mixed metaphor problem.

One way to prevent auxiliary metaphors from mixing dissonantly with the underlying metaphor might be to employ the POPIT model (Cates, 1994) to identify complementary auxiliary metaphors. To eliminate the problem of mixing underlying metaphors, designers could look for a larger unifying primary metaphor. For instance, a clever designer might be able to work around the cemetery/music store problem in a couple of ways. The first would be to make the cemetery not the underlying metaphor, but rather itself an auxiliary metaphor for a larger geographic primary metaphor. A second way would be to couple some sort of transitional device, either visual or navigational that conveyed the sense of going from one location to another with a changed set of auxiliary metaphors that complement the demands of the new location. Keys here would appear to be making the transition easily comprehensible and making the set of auxiliary metaphors in the new location comparable in both function and location to the set provided in the previous location.

Thematic Metaphorical Graphical User Interface (Thematic MGUI)
A Thematic MGUI is an interface in which the auxiliary metaphors are all complementary to the underlying metaphor. The icons and images employed all support the underlying metaphor and help to enhance its believability and efficacy. That is, there is a consistent theme exemplified by the interface and all aspects of the interface appear to integrate this theme. Figures 3 and 4 illustrate how a Thematic MGUI might be used in our exemplary history lesson.



Click on the gate to enter the cemetery:

Figure 3: The entrance screen for a sample Thematic MGUI.

The underlying theme of a cemetery continues to serve as the primary metaphor. The program's entrance (figure 3) and departure are accomplished through the use of a gate; once again, more similar to the way in which one actually gains access to a cemetery. The sample Thematic MGUI in figure 4 uses icons that complement the underlying metaphor. They are objects or functions one might expect to find in a cemetery. Navigation is now based on hearses. Clicking on tombstones elicits biographical data. Some gravesites have larger memorials, statues, or mausoleums. Clicking on large memorials and statues supplies information about why the deceased is better known or more impressively commemorated. Clicking on mausoleums provides information about famous families of deceased persons. Some gravesites carry markers indicating military service and some have flowers. Clicking on military markers makes it possible for the user to gain information about the person's military record. Clicking on gravesites with flowers allows the user to find out why this person is remembered. Some sites may have a person visiting the grave. Clicking on this person enables the user to gain more personal information about the deceased.

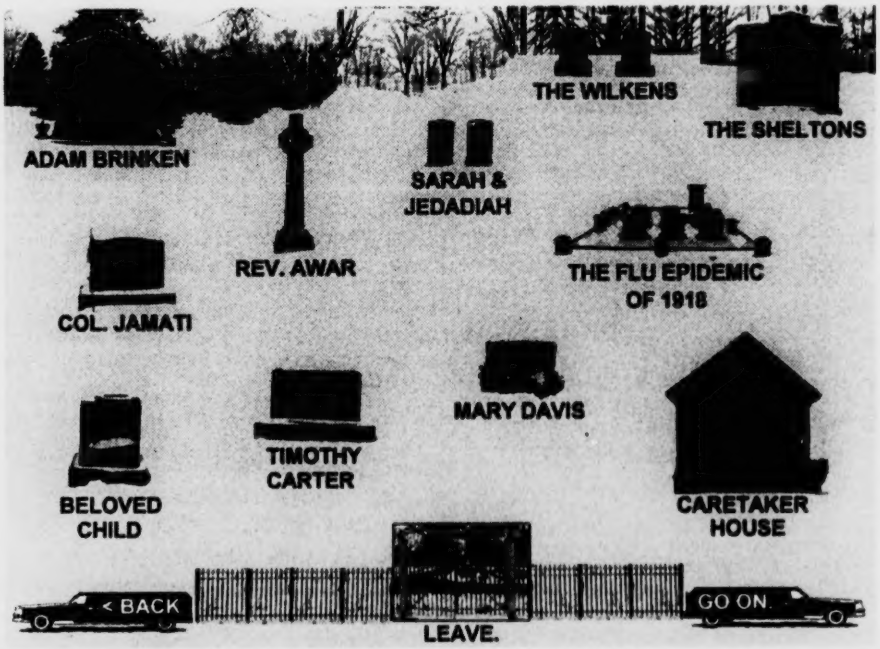


Figure 4: A sample Thematic Metaphorical Graphical User Interface.

Auxiliary metaphors go beyond grave-side information, however. Clicking on a small building on the right side of the screen provides access to a caretaker and cemetery records. The caretaker might serve as a guide or advisor, helping the user decide what to do (Oren, Salomon, Kreitman, & Don, 1990). Clicking on the record book for the cemetery could bring up a plot map of who is buried where and a brief identification of that person, in a fashion similar to what might be done for a real cemetery. There could be funeral parties on which one might click also. Some gravesites are clearly older than others with faded or weather-worn gravestones, while more recent gravesites have newer stones or may have disturbed soil. In each case, we are using aspects of the underlying cemetery metaphor to suggest appropriate complementary metaphors, while at the same time employing conventions to convey recency to users (Brown, 1988).

Thematic metaphorical GUIs are not without their problems. For instance, navigation can present a challenge. In our example, we have maintained lateral navigation across screens in a largely linear fashion. If we were to use hyper-navigation —that is, navigation by linking from one image to another across multiple screens— users could quickly become disoriented. This could prove particularly true if the links took users to screens in which the underlying metaphor were different. In our example, one could use the plot map in the caretaker's house as a navigational device to permit the user to move about the cemetery. This would make it possible to eliminate the *back* and *go on* icons, unless users were required to navigate across metaphorical screens.

Maintaining context and a sense of control are also issues here. Users need to be able to take advantage of crucial features regardless of where navigational actions have taken then. Thus, in our example, moving from gravesite to gravesite using the cemetery map should not leave the user without access to navigation and other key functions. One approach could be to maintain certain things in common locations, regardless of the setting. For example, in the cemetery metaphor, the caretaker's building could always be visible, regardless of the gravesite visited. For instance, the cemetery might be laid out in such a fashion that the caretaker's building were a central device with gravesites radiating out from it like spokes from a wheel (see figures 5 - 8).

Figures 5 - 8: Four views of the caretaker house.

Immersive Metaphorical Graphical User Interfaces (Immersive MGUI)

While thematic GUIs should help to enhance the believability and predictability of the program, they still tend to be "flat." That is, they tend to be based on back-and-forth or simple bidirectional navigation among sites or locations. The next step in GUI design would be to add the third dimension. In an Immersive MGUI, users would find themselves working through an interface that consists largely of three-dimensional representations, creating an interactive environment for the user. Some have termed such an environment a "microworld" (Rieber, 1992). Many of the objects in this environment might be manipulatable. For example, one might be able to pick objects up and examine them from different viewpoints. One might be able to move things from one location to another in a fairly realistic fashion.

Although the Thematic MGUI in figure 4 exhibits some three-dimensional properties, it does not provide much in the way of manipulation. Users click on labeled tombstones, mausoleums, statues, and the caretaker house. What they do not do is manipulate and navigate dynamically in the third dimension. In an Immersive MGUI, users might manipulate and reconstruct broken tombstones from pieces found lying on the ground. They might be asked to find missing gravesites or missing bodies by using information that was available through manipulation, perhaps even through exhumation (accompanied by appropriate ethical, legal, and religious actions). The devices offered by the Immersive MGUI might include such tools as shovels, metal detectors, sonic finders, even bulldozers and backhoes. Instead of simply clicking on objects, usually in isolation, users do more dragging and dropping and more combinatorial activities. Thus, for instance, instead of clicking on a tombstone or a box of charcoals to get a rubbing, users must drag an appropriate size piece of tracing paper to the stone, attach it properly, obtain a charcoal, and then rub the charcoal from side to side across the stone until a satisfactory image is obtained.

Two key components of Immersive MGUIs are the use of three-dimensional objects and images and the provision and expectation of enhanced manipulatability. Immersive MGUI design appears based largely on the assumption that users who are immersed in such an environment will feel a greater sense of believability and involvement. This, in turn, may lead to more active exploration and enhanced understanding.

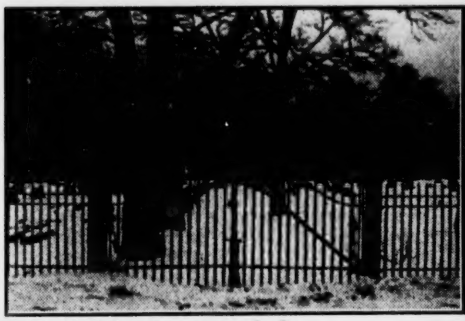


Figure 9: Initial entry screen before user clicks.

Figure 10: Second image in entry transition screen.

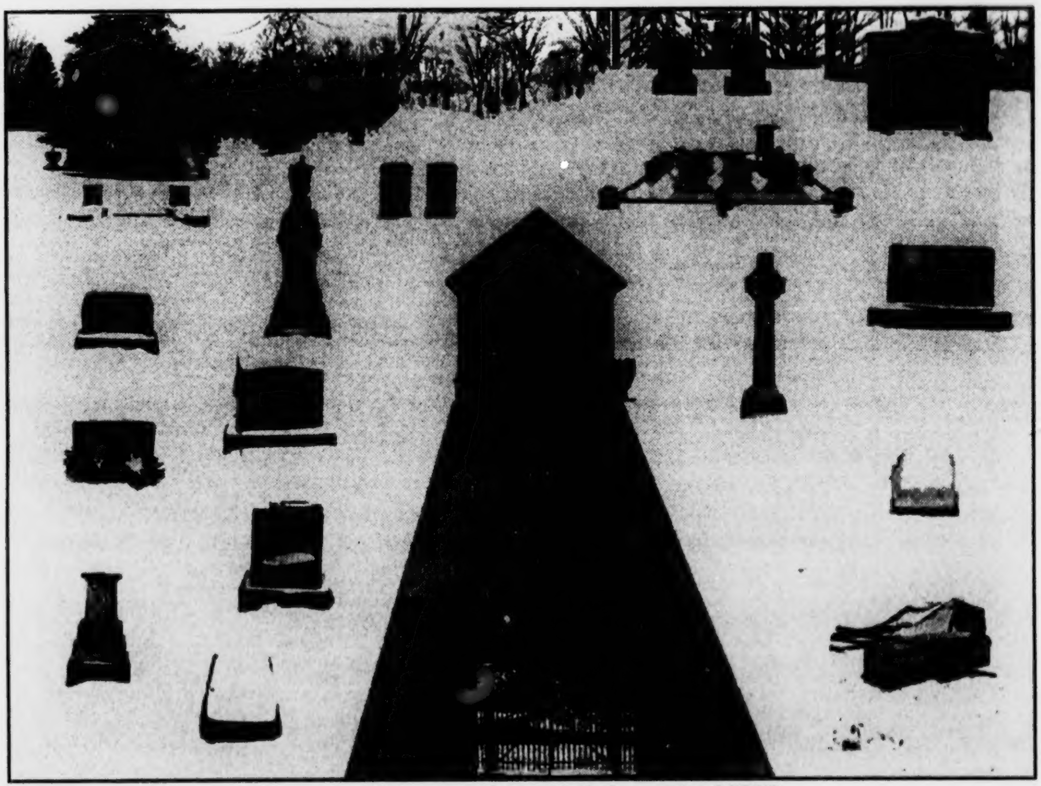


Figure 11: Main screen for a sample immersive MGUI.

It is quite difficult to portray an Immersive MGUI in still pictures. The interactive nature of the program and the advantages and impressions of animation and zooms are lost in still pictures. This paper will do its best to illustrate how our exemplary history lesson might be implemented in an Immersive MGUI. Figures 9 and 10 illustrate the transition sequence that takes a user from initial click to the cemetery's main screen.

At the end of the entry transition sequence, users will find themselves at the main screen (see figure 11). Notice that the labeled icon approach of the sample Thematic MGUI (figure 4) has been replaced by unlabeled objects. Notice also that there are many more objects visible on this screen. Recognize that this screen is actually a window on a larger "virtual" cemetery. That is, when learners move to the far right or far left of this screen, they can change viewpoint to see more cemetery and more gravesites. As suggested earlier and illustrated in figures 5-8, the caretaker house will remain a

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centrally accessible device. Thus, navigation within this environment is actually rotation around the hub of the caretaker house.

The plot map in the caretaker's house is now a reference sheet, not a navigational device. Users can get a copy of the plot map to take with them if they wish. Notice that some gravesites appear covered with snow. Users will be able to obtain devices (brooms, shovels, rakes, and the like) at the caretaker's house and can use these to clear gravesites. Notice also that there is a fresh gravesite on the right side of the initial screen. Immersive MGUIs can be incredibly rich environments, providing the potential for a greater sense of user engagement and involvement.

At the same time, however, immersive metaphorical GUIs aren't for everyone or every application. They are exponentially more difficult to code. The task at hand must lend itself to manipulation, exploration, and three-dimensionality. Lots of reading isn't well served by immersion. One has to consider how navigation and manipulation will be handled. In terms of navigation, will you use arrows to tell the user that he or she can go right, left, up, and down? Will you allow the movement of the mouse pointer to cause the visible screen window to pan across some larger virtual screen? If so, how will you handle the loss of reference point so famous for inducing seasickness? In terms of manipulation, will the mouse pointer change shape or form when different actions are possible? Will you employ sounds to assist users in determining what is happening? In short, how will you help users handle the disorientation and confusion that often accompany more complex environments? (Marchionini, 1988; Oren, 1990). In order for Immersive MGUIs to function effectively, they must enhance and complement, not confuse and frustrate users.

How will you help users maintain continuity and context? Will you supply them with a backpack or a bag in which to carry useful devices? Will you supply a notebook? How will it be used and when? Will all the devices the user carries be accessible all of the time? How will you let users know what they are supposed to do while in the environment? How will you determine if the user is doing what he or she needs to do and how will you assess the user's progress toward the desired goal (if such a goal exists)? In short, there are many crucial design considerations that require thoughtful analysis and careful design.

Closing Comments

For purposes of illustration, this paper has used rather simplistic illustrations. In contrast, the demands of functionality and content may well dictate that a program provide substantially more of both. At the same time, this paper has attempted to highlight what might be considered the more salient concepts and questions in designing metaphorical graphical user interfaces.

Good interface design goes well beyond simple adherence to rules or selection of pleasing graphics. It addresses user needs and the demands of the setting in which the program will be used. Thus, interface design, like all good software design, is a creative act. It requires great care and great forethought. Since metaphorical interfaces function largely by tapping into the schemata and experiences of their users, designers need to pay particular attention to the models and experiences of those users. Although not without price, a workable and useful metaphor is a pearl of great value.

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Title:

Factors Contributing to Students' Preconceptions of Mediated Science Instruction for Various Domains of Learning

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Factors Contributing to Students' Preconceptions of Media

Computers are becoming an integral part of teaching; yet books remain the primary source of conveying instructional content. Television and videotapes also are used to provide realistic pictures, moving images, audio narration and music to supplement instruction. And multimedia provides the opportunity to combine features of each of these three media.

Although the commonly accepted viewpoint is that "...media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes change in our nutrition" (Clark, 1983, p. 445), Kozma (1991) has challenged and expanded this commonly held view and proposed that the "capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the ways learners represent and process information and may result in more or different learning when one medium is compared to another for certain learners and tasks " (p. 179).

Kozma (1991) defines media in terms of it's technology, symbol systems, and processing capabilities. The technology, or hardware, primarily affects the location at which instruction can occur. The symbol systems of a medium include the way it presents verbal and visual information. Processing capabilities refer to the ability of a medium to provide random access to information, learner control over the pacing, and other arithmetic and logic functions. Although the technology is assumed to have minimal effects on learning, the symbol systems and processing capabilities of media may affect the nature of the information gained and the way the information is processed. Kozma further states that "whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning situation- *the tasks and learners involved* [italics added]- and the way the medium's capabilities are used by the instructional design" (Kozma, 1991, p. 182.

Research indicates that learners' beliefs about an instructional delivery system may be one factor that affects the cognitive processing of content delivered through that medium (Krendl, 1986; Richey, 1992; Salomon, 1983; Salomon & Leigh, 1984, and others). Research conducted with sixth grade students found that the perceived ease of learning from a medium was negatively correlated with achievement (Salomon, 1983; Salomon & Leigh, 1984); however, research conducted with post-secondary learners has found a significant positive correlation between the perceived ease of learning from a medium and achievement scores (Cennamo, Savenye, & Smith, 1991; Richey, 1992). For example, Richey (1991; 1992) used path analysis to examine the causal influence of a number of variables on the achievement scores of over 600 participants in industrial training programs. She found that "on the average, sixty percent of the outcomes of these training programs can be predicted by the adult learners' entering characteristics and perceptions, most of which are directly or indirectly related to one's perceptions of the training delivery system" (Richey, 1991, p. 16). These results suggest experienced learners may be accurately aware of the ease with which they learn from a particular medium.

But what influences learners' attitudes toward media? Why do learners view one medium as easier or more difficult than another for a particular task? Recognizing the learners' voices in what makes it easy to learn a particular task from a particular medium may provide instructors and materials developers with important practical implications for their design and development efforts.

Earlier research (Salomon, 1984; Salomon & Leigh, 1984; Krendl, 1986) found that learners' preconceptions of the ease or difficulty of learning a lesson depended on the medium of presentation; however, other researchers have found that the perceived ease of learning a lesson from a particular medium was also dependent upon the topic of the lesson (Beentjes ,1989) and the learning domain (verbal, intellectual, attitude, or psychomotor) of the instructional objective (Cennamo, 1993b).

Recently a series of studies has been conducted to determine factors influencing learners' perceptions of the ease of learning a particular task using a particular medium. In an exploratory study (Cennamo, 1993a), 12 preservice teachers completed a self-report questionnaire assessing their preconceptions of the ease of achieving various learning outcomes (psychomotor, affective, verbal, intellectual) using the media of interactive video, computers, books, and television. They were interviewed to determine the reasoning behind their ratings. Analysis of the interview responses indicated that for different domains of learning outcomes, learners used different criteria for rating a medium as easy or difficult. Consistent with Kozma's (1991) theory, learners' ratings of the ease of learning a particular task using a particular medium were influenced by the a) capabilities of the medium (such as the symbol systems and processing capabilities), b) characteristics of the learner (such as past experience and personal preferences), and c) characteristics of the task (such as complexity of the learning objective). However, the particular factors that were perceived to be of major importance varied depending on the medium and domain of learning outcome.

The current study attempted to validate and extend the prior study. The purpose of this study was to determine whether similar patterns are found a) when interviewing a larger number of participants and b) when focusing on a specific content area. Whereas interviews were conducted with only 12 participants in the previous study, 38 interviews were conducted in the current study. In addition, the questionnaire used to elicit verbal responses in the previous study contained learning objectives from a variety of content areas. In the current study, the interview questions have been restricted to objectives from the science content area.

Methods

Participants

Thirty-eight undergraduate students enrolled in an undergraduate computer education class in a large midwestern university volunteered to participate in individual interviews. Of the 38 participants, 34 were female and 4 were male. Twenty-four (63%) were Education majors, 11 (29%) were majoring in Child Development and Family Services, and three (8%) were majoring in other areas. 42% were seniors (16), 45% were juniors (17), and 13% (5) were sophomores.

Materials

During the interview, a preconceptions questionnaire was used to evoke students' perceptions of the ease of learning from books, television, computers, and interactive video. It included a cover sheet that operationally defined each medium in order to ensure that all participants interpreted the terms "books", "television", "computers", and "interactive video" in the same manner (see Appendix). The students were asked to rate the difficulty of learning 12 tasks using each of the four media on a five-point Likert scale and to orally justify their ratings. One represented "very easy" and five represented "very difficult". The questions were similar in format to those used by Beentjes (1989), Salomon (1984), and Cennamo (1993a; 1993b). This questionnaire included questions such as:

- How easy would it be to learn to weigh a sample to the nearest 1/10 of a gram using a digital scale from

a book?	*very easy*	1	2	3	4	5	*very difficult*
television?	*very easy*	1	2	3	4	5	*very difficult*
a computer?	*very easy*	1	2	3	4	5	*very difficult*
interactive video?	*very easy*	1	2	3	4	5	*very difficult*

There were three questions for each learning domain (intellectual, verbal, psychomotor, and attitudes). The following questions stems were included:

Verbal information

- How easy would it be to learn to list three rules you should follow when working in a chemistry lab from...
- How easy would it be to learn to define terms that describe the basic units of matter including atoms, elements, molecules and compounds from...
- How easy would it be to learn to label the parts of a cell from...

Intellectual Skills

- How easy would it be to learn to balance a chemical equation from...
- How easy would it be to learn to determine the results of a genetic cross using a Punnett square from...
- How easy would it be to learn to develop and test a hypothesis when conducting an experimental study from...

Psychomotor Skills

- How easy would it be to learn to measure a liquid sample using a graduated cylinder from...
- How easy would it be to learn to weigh a sample to the nearest 1/10 of a gram using a digital scale from...
- How easy would it be to learn to mount and correctly focus a slide on a microscope from...

Attitude Skills

- How easy would it be to learn to voluntarily choose to wear safety glasses while working a in a chemistry lab from...
- How easy would it be to learn to appreciate the biological diversity of the natural world from...
- How easy would it be to learn to choose to treat the environment in a respectful manner from...

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Numerical responses were averaged across domain and medium to provide an average score for each medium /domain combination. For example, there was an average score for books/ verbal, books/ intellectual, books/ attitudes, and books/ psychomotor. Chronbach's alpha yielded an acceptable overall reliability coefficient of .79.

Procedures

During the seventh week of class, the researcher invited the participants to sign-up for individual interviews. Although the participants were offered a small amount of extra credit for participation in the interview, the structure of the course allowed the students to earn course credit in a variety of ways throughout the semester. As they reported to the interview site, a research assistant explained the purpose of the interview and presented the participants with the questionnaire. Borg and Gall (1993) indicate that matching interviewers and respondents on variables such as social class, age, and gender may produce more valid responses; thus, like the majority of the respondents, the interviewer was an undergraduate student, female, and approximately 20 years old.

Using an interview guide, she conducted each interview in a consistent manner. The interviewer read the cover sheet aloud and waited for the respondents to complete the demographic questions. Then the interviewer read each question aloud. The students were asked to indicate their rating on the 5-point scale and to orally reflect on why they rated the medium as they did. These conversations were audiotaped and later transcribed.

Data Analysis and Results

Initial analysis focused on student's familiarity with the four media. One-hundred percent of the respondents indicated that they used books once a month or more, 97% indicated that they watched television once a month or more, and 92% indicated that they used computers once a month or more. However, 92% of the respondents indicated that they "hardly ever" used interactive video. Based on the infrequency of use, responses to questions addressing the perceived ease of learning from interactive video were eliminated from the data analysis. Subsequent analysis focused on learners' perceptions of the perceived ease of learning science content from books, television, and computers.

The interview responses were of primary importance in determining factors that contribute to learners' perceptions of the ease of learning from a particular medium. Responses to the questionnaire were analyzed quantitatively to provide guidance in interpreting the interview responses. Student ratings on the Likert scale were analyzed using a Repeated Measures Analysis of Variance to determine whether students preconceptions of the ease of learning science tasks varied by learning domain, by medium, or randomly depending on topic. Based on the findings of the statistical analysis, the interview data were analyzed to determine factors influencing learners' preconceptions of the ease of learning a skill in a given domain using a particular medium.

Analysis of Questionnaire Data

The Repeated Measures Analysis of Variance indicated several significant findings concerning learners' preconceptions of the ease of learning a given outcome using a given medium of presentation. (See Table 1.) Following the finding of a significant F, Tukey's Honestly significant Difference (HSD) test was used to determine significant differences among individual group means.

As expected, there was a significant interaction among learning domain and medium, $F(1,37) = 29.04$, $p < .001$. Learners perceived that it was significantly easier to learn psychomotor skills from television ($M = 2.10$) than from computers ($M = 2.75$) and books ($M = 3.28$), and significantly easier to learn psychomotor skills from computers than from books. For the learning of attitudes, learners also perceived it to be significantly easier to learn from television ($M = 1.48$) than from books ($M = 2.71$) and computers ($M = 2.93$). Learners perceived it to be significantly easier to learn intellectual skills from computers ($M = 2.27$) and television ($M = 2.63$) than from books ($M = 3.00$). Learners rated computers ($M = 1.70$) and books ($M = 1.84$) as significantly easier than television ($M = 2.29$) for learning verbal information. As expected, there was a significant difference among media, $F(1,37) = 18.98$, $p < .001$, and among learning domains, $F(1,37) = 47.01$, $p < .001$. Tukey's post-hoc analysis of the data revealed that television ($M = 2.13$) was perceived to be significantly easier than computers ($M = 2.42$) and books ($M = 2.71$), and computers were perceived to be significantly easier than books. Students perceived that it was significantly easier to learn verbal information ($M = 1.85$) than attitudes ($M = 2.15$), intellectual skills ($M = 2.42$) and psychomotor skills.($M = 2.44$), and significantly easier to learn attitudes than psychomotor skills.

Table 1: **Means and standard deviations of ratings on preconceptions questionnaire.**

		Computers	Television	Books	TOTAL BY DOMAIN
Psychomotor	Mean	2.75	2.10	3.28	2.44
	SD	1.04	1.03	1.12	1.16
Attitudes	Mean	2.93	1.48	2.71	2.15
	SD	1.09	.74	1.15	1.16
Verbal	Mean	1.70	2.29	1.84	1.85
	SD	.86	1.14	.95	.99
Intellectual	Mean	2.27	2.63	3.00	2.42
	SD	.99	1.57	1.21	1.15
TOTAL BY MEDIUM	Mean	2.42	2.13	2.71	
	SD	1.10	1.11	1.23	

Note: Higher scores mean greater perceived difficulty.
N=38.

Interview analysis and results

Based on the results of the statistical analysis, the interview data was interpreted in terms of the media by domain interaction. Data from the interviews were entered into a database and coded as to the question number, medium, and domain addressed by each response. The data were sorted by medium and domain, resulting in a set of responses for books/verbal, books/ intellectual, books/ attitudes, books/ psychomotor, television/verbal, television/ intellectual, television/ attitudes, television/ psychomotor, computers/verbal, computers/ intellectual, computers/ attitudes, and computers/ psychomotor.

Two researchers independently read each statement associated with each medium/domain combination and tallied responses that were similar in meaning. For example "can go back", "can select what you want to study", and "could skip parts you knew" were all coded as "Learner Control".

Based on the categories that emerged during the previous exploratory study (Cennamo, 1993a), the list of responses was clustered into the following categories: symbol system, processing capabilities, task characteristics, personal preferences, and characteristics of the technology. For example "learner control", "practice and feedback", and "lack of interaction" all refer to the processing capabilities of the medium. After clustering the responses by category, the responses in each category were reviewed to verify the placement of each response.

Responses in each category were examined once again to determine if the responses could be further clustered within each category. This analysis revealed that responses addressing the *symbol systems* presented by the various media primarily were concerned with the pictures present, the way the verbal information was presented, the ability of the medium to present demonstrations, the examples and reasons provided, the ability to highlight important information, miscellaneous negative characteristics of the medium, and other miscellaneous responses. Responses that addressed the *processing capabilities* of the medium were primarily concerned with the ability of the medium to provide practice and feedback, learner control, the ability of the student to ask questions or clarify understandings, and other miscellaneous responses. Responses coded as *personal preferences* were mostly individualistic in nature; however, clusters that emerged were based on learners' past experiences or reflected their dislike for the media. *Task characteristics* clustered into those that addressed the ease or difficulty of the task, the suitability of the medium for the task, and other miscellaneous responses. Responses that mentioned characteristics of the technology were rare, thus, the *technology* category was not subdivided further.

Typically, learning outcomes are determined prior to selecting media to deliver the content, thus, the results of this analysis will be discussed by learning domain of the intended outcome.

Attitude skills

Television was rated as significantly easier than computers and books for learning attitude skills (see Figure 1 and Appendix B). The ability of a medium to demonstrate the target skill using realistic pictures seemed to be the most prevalent characteristics influencing learners ratings of the ease of learning attitudes using the three media. In general, pictures were important for the learning of attitudes. The realistic nature of the pictures influenced learners' ratings of the ease of leaning an attitude skill. The presence of a variety of visual examples on television also was important to the participants of the study.

Figure 1. Mean ratings of the ease or difficulty of learning attitude skills.

Easiest			Most Difficult
Means	1.48 *a*	2.71 *b*	2.93 *b*
	Television	Books	Computers

Note: means with different subscripts are significantly different from one another.

The respondents felt that when using computers they would be primarily "just reading" "just facts" and that words would not be very valuable in changing their attitudes. Respondents also perceived that books tell you information and present facts, but mentioned that they were "just words" and indicated that some ideas could not be described well in words. They frequently mentioned that books did not present real situations and that you would not see the results of not changing your attitude. However, the respondents did acknowledge that books an computers could list the possible results of an action and the consequences or reasons why one should change an attitude. Participants acknowledged that television also would present verbal information with respondents mentioning the audio track as important for providing verbal descriptions.

The processing capabilities, characteristics of the task, personal preferences, and technology of a medium did not appear to be as influential as the symbol systems in learners' perceptions of the ease of learning an attitude skill. Personal preferences were stronger for books than the other two media; however, most ideas were mentioned only once, reflecting the individual nature of personal preferences. The perception that reading a book would not influence personal actions was the most frequently mentioned idea coded as a personal preference.

Intellectual Skills

Although computers were rated as slightly easier than television for the learning of intellectual skills, the difference was not significant; both media were rated as significantly easier than books in the learning of intellectual skills (see Figure 2 and Appendix C). Although television and computers were rated similarly for learning intellectual skills, the ratings were attributed to very different characteristics of the media.

Figure 2. Mean ratings of the ease or difficulty of learning intellectual skills.

Easiest			Most Difficult
Means	2.27 *a*	2.63 *a*	3.00 *b*
	Computers	Television	Books

Note: means with different subscripts are significantly different from one another

Participants perceived that demonstrations facilitated the ease of learning intellectual skills. Once again, the strength of television seemed to be in its ability to demonstrate the target skill in a step-by step manner. These characteristics were further enhanced by the audio capacities of television that allow the program to "tell", teach, and explain information. The ability of computers to show how a tasks is performed and "take you through it, step-by-step" also was an important characteristic influencing participants' ratings of computers. These characteristics, coupled with the textual data and instructions contributed to the perceived ease of learning intellectual skills from computers. The perceived textual nature of computer demonstrations may have accounted for the fairly similar number of responses mentioning step-by-step explanations in books. The strength of books seemed to be the presence of examples that illustrate the target skill, which may reinforce the learners perceived need for demonstrations of the target skill.

The processing capabilities of computers were viewed as important factors contributing to the perceived ease of learning intellectual skills. The presence of practice and feedback was the characteristic most responsible for the higher rating of computers than of books and television. Learner control was also perceived as critical in learning intellectual skills. The most frequently mentioned feature of learner control was the ability to review and repeat information.

Task characteristics, personal preferences, and the technology had little influence on the perceived ease of learning intellectual skills. The most frequently mentioned task characteristic was the appropriateness of the medium for teaching the task. Once again, personal preferences influenced students' ratings of books more frequently than the other media. The frequency of responses mentioning characteristics of the technology as influential in their ratings was similar across media.

Psychomotor skills

Television was rated as the easiest medium from which to learn psychomotor skills (see Figure 3 and Appendix D). The presence of demonstrations was especially influential in the learners' rating of the media. The ability of a medium to present directions and "tell how" in a step-by-step manner also was considered in the learners' ratings of the ease of learning psychomotor skills from the three media.

Figure 3. Mean ratings of the ease or difficulty of learning psychomotor skills.

Easiest			Most Difficult
Means	2.10 *a*	2.75 *b*	3.28 *c*
	Television	Computers	Books

Note: means with different subscripts are significantly different from one another

Lack of practice opportunities was perceived as a disadvantage when learning psychomotor skills from television and books, while respondents did not perceive the processing capabilities of computers as particularly relevant to learning psychomotor skills. Students mentioned that they would not be "actually doing it" when learning psychomotor skills on the computer.

The perceived ease or difficulty of the task accounted for the majority of the "task related" responses. However, the suitability of the task for presentation via computer was the most frequently mentioned "task variable" influencing students' ratings of computers.

Personal preferences and the technology were not particularly influential in students' ratings of the ease of learning psychomotor skills

Verbal information

Students perceived it to be easier to learn verbal information from computers and books than from television. (See Figure 4 and Appendix E.) Surprisingly, the presence of pictures illustrations, and diagrams were perceived as important features influencing the ease of learning verbal information from all three media. Students continued to value the demonstrations provided by television. Also surprisingly, students perceived the three media as being fairly equal in their ability to present verbal information.

Figure 4. Mean ratings of the ease or difficulty of learning verbal information.

Easiest			Most Difficult
Means	1.70 *a*	1.84 *a*	2.29 *b*
	Computers	books	Television

Note: means with different subscripts are significantly different from one another

The processing capabilities of the media were important to the learners' ratings of the ease of learning verbal information from books, computers, and television. Participants mentioned the ability to review and refer back to information presented through books and computers. This ability to refer back to information with ease, coupled with the participants perceptions that the task required memorization and rehearsal of the information may have accounted for the perceived ease of learning verbal information from computers and books. The ability of the computer to provide drill and practice with feedback also contributed to the perceived ease of learning verbal information from computers.

Participants felt that the ease or difficulty of the task was more relevant to learning from books than other media. In addition, students perceived books to be more appropriate for learning verbal information than computers or television.

Neither personal preference or the technology seemed to be particularly important to the perceived ease of learning verbal information from the three media.

Summary and Discussion

Discussion

This study was conducted as an initial step in determining factors that contribute to learners' preconceptions of the ease or difficulty of learning science tasks in the attitude, psychomotor, intellectual, and verbal information domains using computers, television, and books.

Consistent with the results of a previous study (Cennamo, 1993a), the students' ratings of the ease of learning various tasks using computers, television, and books seemed to reflect some awareness of the external conditions needed for optimal learning in each domain (Gagné, 1985; Gagné, Briggs, & Wagner, 1992). Opportunities for rehearsal can enhance the learning of verbal information, and books and computers, the two media where the pacing is under the control of the learner, were rated as the easiest from which to learn verbal information. Likewise, the learners' ratings of the ease of learning intellectual skills from computers reflected an awareness that opportunities for practice and feedback with a variety of examples can enhance the learning of intellectual skills.

From the responses to the interview questions, it appears that for these non-science majors, visual imagery is important in learning science content. Learners in a prior study (Cennamo, 1993a) who responded to questions about the ease of learning a variety of skills in several content areas indicated that demonstrations were important in learning psychomotor skills and attitudes; the learners who responded to questions specifically addressing science content indicated that demonstrations enhanced learning for all domains but verbal information. However, these learners indicated that pictures and illustrations increase the ease of learning verbal information. Kozma (1991) indicates that visual images are particularly important when learning new content, suggesting that pictures provide learners with a mental model onto which they can then map the information provided by the text. It is likely that the undergraduate students majoring in education and child and family development may have lacked confidence in their understanding of the science content, thus, they may have felt the need for a concrete visual image.

Kozma (1991) suggested that "whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning situation- the tasks and learners involved- and the way the medium's capabilities are used by the instructional design." (p. 182). From the responses to this study, it seems that students' perceptions of the ease of learning a particular skill using a particular medium was influenced by their perceptions of the way a medium's characteristics are used by the instructional design. They perceive television to include demonstrations and realistic pictures. They perceive computers to include graphics and practice with feedback. As students have more experience with computer programs capable of presenting visual and verbal information with the realism currently associated with television, students' perceptions of computers will likely change to reflect a broader definition of computer assisted instruction. In addition, they indicated that "the task and learners involved" did influence their ratings of the ease of learning science skills from the three media. Personal preferences and characteristics of the task such as the domain of the target skill, the perceived ease or difficulty of the target task, and the perceived appropriateness of the media for teaching the task were important to the participants.

These results reinforce that it is important to consider the target skill in selecting media for instruction. Given the results of this study, it is surprising that the majority of college level instruction uses books as the primary method of relaying science content. Most college level instruction focus on teaching intellectual skills such as concepts, rules, and problem solving rather than attitudes, psychomotor skills, or verbal information. However, books were rated as the most difficult medium from which to learn intellectual skills. Although science majors may have different perceptions of the ease of learning from books, this study suggests that perhaps computers should be used to teach intellectual skills and verbal information to novice learners. Perhaps television or videotapes should be used to teach attitudes and psychomotor skills. Perhaps it will be even better if designers of computer-based lessons for teaching science content incorporate "television like" sequences and images in multimedia programs designed to teach intellectual, attitude, or psychomotor skills. However, the inclusion of realistic, moving images and sound in computer-based instruction requires large amounts of computer memory and storage. Thus, an awareness of situations where learners perceive realistic images and sound as important for the ease of learning remains important.

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Appendix A. Cover sheet for preconceptions questionnaire.

Preconceptions Questionnaire **NUMBER** __________

This questionnaire is designed to examine your preconceptions of four forms of media. Specifically, it is designed to determine your perceptions of the ease or difficulty of learning from books, television, computers and interactive video.

As you know, instruction can be presented in a variety of media formats. Throughout your education, you have probably read many books and seen quite a few videotapes. You may or may not have had experience in computer assisted learning or interactive video based instruction. Since this questionnaire is about your preconceptions of books, television, computers, and interactive video, the terms will be operationally defined as explained below:

For the purposes of this questionnaire, when you see...

Books: Please imagine that you are reading text materials supplemented with photographs and illustrations.

Television: Please imagine that you are watching a series of moving video images, supplemented with narration, music and other sound effects. Appropriate illustrations, still pictures, or text screens may also be presented.

Computers: Please imagine that you are using a computer program that contains text screens and graphic illustrations. Animation may be used to create moving images. There is no sound. At certain points in the program, it will be necessary to make a selection from a menu or to respond to a prompt or question before the program will continue.

Interactive video: Please imagine that you are using a program that combines computer generated screens with video images. The video display may include moving and still images, narration, music and sound effects. The computer display may include text screens, graphic illustrations, and animation. At certain points in the program, it will be necessary to make a selection from a menu or to respond to a prompt or question before the program will continue.

Please indicate your gender ...... ( ) male ( ) female

Please indicate how frequently you use

Books	( ) almost never	( ) once a year	( )once a month	( ) once a week or more
Television	( ) almost never	( ) once a year	( )once a month	( ) once a week or more
Computers	( ) almost never	( ) once a year	( )once a month	( ) once a week or more
Interactive Video	( ) almost never	( ) once a year	( )once a month	( ) once a week or more

Appendix B. Factors influencing participants' ratings of the ease or difficulty of learning attitude skills from computers, books and television.

Books/ Attitudes	
Symbol systems	98
Still Pictures	28
Words, tell, facts	27
Negatives	19
List results	17
Examples	6
Miscellaneous	1
Processing	10
Lack of interaction	8
Learner control	2
Task	8
Easy task	6
Miscellaneous	2
Personal Preferences	24
Won't affect actions	6
Miscellaneous	18
Technology	3

Computers/ Attitudes	
Symbol systems	138
Lack of real images	29
Not seeing task or outcome	25
Graphics, pictures	20
Words, tell, facts	32
Reasons	15
Shows you	5
Miscellaneous	12
Processing	4
Miscellaneous	4
Task	7
Miscellaneous	7
Personal Preferences	6
Miscellaneous	6
Technology	0

TV/Attitudes	
Symbol systems	146
Demonstration	86
Realistic pictures	22
Variety of examples	14
Audio	14
Miscellaneous	10
Processing	1
Miscellaneous	1
Task	6
Miscellaneous	6
Personal Preferences	5
Miscellaneous	5
Technology	0

Appendix C. Factors influencing participants' ratings of the ease or difficulty of learning intellectual skills from computers, books and television.

Books/Intellectual skills	
Symbol systems	68
Examples	23
Explains, step-by-step	21
Words & equations printed	12
No demonstration	5
Miscellaneous	7
Processing	34
Lack of practice	25
Learner control	9
Task	28
Ease or difficulty of task	10
Not appropriate for medium	12
Miscellaneous	6
Personal Preferences	15
Past experience	10
Takes much time	5
Technology	3
Miscellaneous	3

Computers/ Intellectual	
Symbol systems	76
See, step-by step	32
Examples	14
Tells	16
Pictures/ graphics	7
Miscellaneous	7
Processing	73
Practice and feedback	55
Learner control	18
Task	9
Miscellaneous	9
Personal Preferences	9
Media difficult	4
Miscellaneous	5
Technology	3
Miscellaneous	3

TV/Intellectual	
Symbol systems	128
Demonstrate, step-by step	72
Tell you	32
Realistic pictures	8
Examples	6
Written text	7
Miscellaneous	3
Processing	27
Practice and feedback	13
Learner control	9
Unable to clarify	5
Task	14
Not appropriate for medium	5
Miscellaneous	9
Personal Preferences	7
Miscellaneous	7
Technology	0

Appendix D. Factors influencing participants' ratings of the ease or difficulty of learning psychomotor skills from computers, books and television.

Books/ Psychomotor	
Symbol systems	76
Pictures, illustrations	24
No demonstration	22
Tells how	17
Examples	4
Miscellaneous	9
Processing	42
Lack of practice & feedback	36
Learner control	4
Miscellaneous	2
Task	26
Ease or difficulty of task	17
Not appropriate for medium	9
Personal Preferences	4
Miscellaneous	4
Technology	2
Miscellaneous	2

Computers/ Psychomotor	
Symbol systems	109
Graphics, visuals	56
Show how	21
Tell how	25
Miscellaneous	7
Processing	20
Practice and feedback	18
Miscellaneous	2
Task	19
Not appropriate for medium	17
Miscellaneous	2
Personal Preferences	3
Miscellaneous	3
Technology	0

TV /Psychomotor	
Symbol systems	143
See how	108
Realistic, clear pictures	18
Tells you	12
Miscellaneous	5
Processing	22
Lack of practice	22
Task	10
Ease or difficulty of task	6
Miscellaneous	4
Personal Preferences	6
Miscellaneous	6
Technology	0

Appendix E. Factors influencing participants' ratings of the ease or difficulty of learning verbal information from computers, books and television.

Books/ Verbal	
Symbol systems	79
Pictures	35
State facts, describe	29
Important information evident	11
Miscellaneous	4
Processing	18
Learner control	18
Task	63
Ease or difficulty of task	21
Task requires memorization	42
Personal Preferences	6
Miscellaneous	6
Technology	0

Computers/Verbal	
Symbol systems	83
Graphics, visuals	40
Important information evident	11
Words, tells	25
Miscellaneous	7
Processing	56
Practice and feedback	32
Learner control	21
Miscellaneous	3
Task	23
Task requires memorization	9
Ease or difficulty	6
Not appropriate for medium	8
Personal Preferences	10
Miscellaneous	10
Technology	3
Miscellaneous	3

TV /Verbal	
Symbol systems	122
Shows you	36
Realistic pictures	29
Tells you	20
Text	20
Examples	6
Audio	5
Miscellaneous	6
Processing	25
Learner control	24
Miscellaneous	1
Task	21
Not appropriate for medium	9
Ease or difficulty of task	4
Task requires memorization	4
Miscellaneous	4
Personal Preferences	11
Miscellaneous	11
Technology	1
Miscellaneous	1

Title:

The Effects of Relevance on Mental Effort

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The Effects of Relevance on Mental Effort

It is a commonly accepted that learners view video as an easy, passive medium, and thus invest little mental effort in processing the information (the "couch potato"). This assumption is primarily based on a series of studies that Salomon (Salomon, 1983; Salomon, 1984; Salomon & Leigh, 1984) conducted in the early eighties. In these studies, Salomon found that learners perceived it to be "easier" to learn from television than books, reported spending less mental effort in learning from videotape than from books, and recalled less from a video-based version of a story than from a print -based version. Salomon assumed that learners perceptions of video or television as "easy" resulted in the investment of less mental effort, and consequently less learning achievement, when compared to reading books.

We could assume from these conclusions that it is preferable to provide instruction in a printed form; however, video remains a popular means of conveying instruction, particularly in the training environment. In fact, a recent survey conducted by Training magazine reported that the use of videotape for conducting corporate training was exceeded only by stand-up instruction (Froiland, 1993).

The majority of research investigating the mental effort invested in instructional videotapes has been conducted with elementary and middle school children (Beentjes & van deer Voort, 1993; Sherman, Salomon, 1983; Salomon, 1984; Salomon & Leigh, 1984). Although several researchers have investigated the amount of effort that college students invest in processing print lessons (Britton, Muth, & Glynn, 1986; Britton, Piha, Davis, & Wehausen, 1978; and others) and television commercials (Lang, Geiger, Strickwerda, & Sumner, 1993; Reeves & Thorson, 1986; and others), there has been very little research that has systematically investigated the mental effort older learners expend in learning from video-based instructional materials. As older learners may have more well developed strategies for learning from videotape that elementary and middle school students, it is important to investigate the extent to which Salomon's conclusions apply to the adult population.

Salomon (1983a) defines the construct of "mental effort" as the "number of non-automatic elaborations applied to a unit of material" (p. 42). In contrast to automatic processing that is fast and effortless, non-automatic processing is deliberate, conscious, and very much under the control of the individual. As new information is received, the new information cues the retrieval of related prior knowledge (E. Gagne, 1985) stored in the learner's schemata. The learner is then able to make connections between the new information and information retrieved from prior knowledge; this process is referred to as elaboration (E. Gagne, 1985). The increased contact with the learner's mental schemata that results from the conscious, non-automatic generation of elaborations, or mental effort, is presumed to facilitate the retention and retrieval of the new material.

The search for techniques to increase the effort that learners invest in video-based instruction has been hindered by the limitations of the instruments used to assess the construct of mental effort. Early work (Salomon, 1983; Salomon, 1984; Salomon & Leigh, 1984) that investigated the amount of effort learners invested in print and video-based instruction used self-report questionnaires to document the learners' effort expenditures. However recently, researchers (Beentjes, 1989; Cennamo, Savenye, & Smith, 1991) have identified a need for more precise methods of assessing mental effort. Beentjes (1989) accurately states that "... validation studies in which mental effort is assessed by multiple methods are called for." (p. 56).

Secondary task techniques have been used to assess effort in a variety studies using print (Britton, Muth, & Glynn, 1986; Britton, Piha, Davis & Wehausen, 1978; and others) and television commercials (Lang, Geiger, Strickwerda, & Sumner, 1993; Reeves & Thorson, 1986; and others), and seem to offer a promising method of assessing the mental effort invested in video-based lessons. When using the secondary task technique, a participant completes a primary task (reading, watching a video, etc.) and at the same time is instructed to respond to a secondary task such as a beep or flash of light as quickly as possible. Researchers assume that as learners spend more cognitive resources on the primary task, they have less cognitive resources left to allocate to the secondary task. They assume that slower reaction times to the secondary task indicate that additional cognitive effort is being allocated to the primary task.

Although Salomon's questionnaire and the secondary task technique are assumed to both measure mental effort, the results of a recent study call that assumption into question. Beentjas and van der Voort (1993) assessed the effort that fourth and sixth grade students invested in two print-based stories and the "structurally equivalent" video-based versions. While students were reading or viewing the stories, they responded to a secondary task, an audible beep, by pressing a key as quickly as possible after hearing the beep. After they completed the stories, they responded to a self-report questionnaire of mental effort that was based on Salomon's instrument. Then they completed an achievement test. The researchers found very low correlations between students scores on the questionnaire and the secondary task measures of effort. In addition, the correlations between scores on both measures and achievement scores on a test of recall inferences were also very low. To further complicate the search for a valid means of assessing mental effort, students reported spending significantly more effort in reading the text versions than in viewing the videotapes. However, when reaction times to the secondary task were used as a measure of mental effort, the opposite effects were found; reaction times were significantly longer, indicating more mental effort, for the videotaped versions than the text versions. Beentjas and van der Voort state that further research is needed on the validity of both methods of assessing mental effort. They suggest that one promising area of investigation may be to determine to what extent both measures are sensitive to manipulations that are intended to increase mental effort.

But what manipulation? No prior studies have manipulated variables designed to increase mental effort and assessed increases in effort using the secondary task technique and a questionnaire. To select a manipulation that has been shown to increase mental effort as measured by a self-report questionnaire (fun/learn for example) may be biased toward demonstrating effects on the questionnaire. To select a variable that has been shown to increase mental effort as measured by the secondary task technique (related or unrelated cuts, for example) may be biased toward demonstrating effects on the secondary task measure . To further complicate the selection of variables, the vast majority of research that has used reaction times to a secondary task as a dependent variable has manipulated features of either text or video, not both. To select a variable that is effective in print may bias the results toward print; conversely, to select a variable that is effective in videotape may bias the results toward that medium.

Mental effort refers to the choice on the part of the learner to allocate cognitive resources to elaborating on an idea, thus, it has motivational as well as cognitive components (Salomon, 1983). According to Keller (1983), motivation "refers to the choices people make as to what experiences or goals they will approach or avoid, and the *degree of effort* they will exert in that respect." (p. 389, italics in original). He further distinguishes between effort and performance: "*Performance* means actual accomplishment, whereas *effort* refers to whether the individual is engaged in actions aimed at accomplishing the task. Thus effort is a direct indicator of motivation" (p. 391). Based on the literature in motivational theory, Keller's ARCS Model of Motivation (1983) breaks the concept of motivation down into four parts (attention, relevance, confidence and satisfaction). Keller provides specific strategies that instructional designers can use to increase learner's motivation, or the effort expended in accomplishing an instructional task.

According to Keller's (1983) ARCS model, one promising technique for increasing learner's motivation, and thus their mental effort, involves increasing the personal relevance of the material. When instruction is perceived as relevant, learners perceive that *important personal needs* are being met by the learning situation" (p.406, italics in original)

Nwagbara (1993) presented learners with two versions of a videotape to examine the effects of relevance on learners motivation toward learning the steps involved in creating a document using a desktop publishing system. Half the learners received the "standard" videotape and half received a "motivationally enhanced" version of the program that included scenes to increase the relevance of the lesson for the learners. He found that learners reported a greater willingness to expend effort in watching the motivationally enhanced videotape than in watching the same program without the motivational enhancements. Although the actual effort expended in the lesson was not assessed, these results suggest that increasing the perceived relevance of a lesson may encourage learners to invest more mental effort in learning the material.

The purpose of this study was to manipulate the degree of "relevance" present in both a videotaped and print versions of a lesson to determine whether increasing the relevance of a lesson increases the amount of mental effort invested in the lesson. In addition, mental effort was assessed using both the secondary task technique and a self-report questionnaire to determine the more valid way of assessing mental effort. And finally, the study was conducted to determine the extent to which Salmon's conclusions apply to learners of college age. The following research questions were addressed:

a)Do learners invest more effort in print-based versions of the lessons than in video-based lessons?
b) Do learners invest more mental effort in motivationally enhanced lessons than in "standard" lessons which lack these characteristics?
c) Do learners' self-reports of effort correlate with their "on-line" measurements of effort collected using a secondary task technique?
d) Do learners mental effort scores (from secondary task or self-report measures) correlate with their post-test scores on recall measures

Methods

For this study, a 2 (text vs. video) X 2 (enhanced vs. standard versions) X 2 (secondary task vs. non-secondary task) design was used. Eight sessions were scheduled over a two week period with treatments randomly assigned to each of the eight sessions.

Participants

Students enrolled in a sophomore level education course at a large Midwestern University were invited to participate in a two hour lesson on desktop publishing. Of 225 students invited to participate, 130 students volunteered for the study. Thirteen cases were eliminated due to incomplete data (failed to complete the mental effort questionnaire, failure to respond to the secondary task, or to problems with the data collection equipment). After eliminating incomplete data sets, 117 participants remained in the study. Participants were both male (N= 35) and female (N=82).

Instructional Materials:

Instructional materials consisted of four lessons: a) a "standard" video on desktop publishing, b) a motivationally enhanced videotape , c) a text version of the "standard" lesson, and d) a text version of the motivationally enhanced lesson.

The two videotapes were used in Nwagbara's (1993) previous study. The "standard" video tape is a commercially available product. The motivationally enhanced videotape was created by editing segments designed to increase the personal relevance of the material into the commercial videotape.

Keller (1987) suggests that to increase the relevance of a lesson, instructional designers should provide goal orientation, motive matching, and familiarity. Goal orientation can be created by relating the benefits of instruction to getting a job, getting a promotion, or improved job performance, or other goals that may be of value to the learners. The goals of the lesson should be clearly presented or learners should have the opportunity to set their own goals. In addition, learners must understand how the concepts and skills are related to their present or future goals. For learners who are present oriented, the instructional content can be related to their current interests. For future oriented learners, the instruction must provide a rationale as to how the information will be helpful in the future. Motive matching can be enhanced by providing personal achievement opportunities, cooperative activities, and positive role models. Learners should be encouraged to assume responsibility for his or her own behavior and the materials should promote perceptions of self-improvement on the part of the learners (McClelland, 1965; Keller, 1983). Familiarity can be increased by using concrete examples from settings familiar to the learner; stories, pictures, or testimonials about specific people or things familiar to the learner; and through the use of analogies (Keller, 1984).

Following Keller's (1983; 1987) recommendations, motivational elements were added to a) illustrate concrete and provide practical examples, b) provide goals for the learners, c) provide positive role models through testimonials from product users, d) illustrate how the lesson might help the learner improve their present and future skills, e) encourage learners to assume responsibility for their learning, and e) illustrate how the skills are useful. For example, a section was added that stated:

> " Some of you may have used the computer at home or in school to do some assignments, write term papers, and other interesting things. You'll see that some of the things you already know about computers, like how to turn the power on, how to use the mouse, or your familiarity with the buttons on the key board will be handy and helpful to you in the process." (Familiarity)
>
> "Gaining the knowledge and skills in this presentation will open a variety of windows of opportunities for you in the world of work in terms of good jobs, good salaries, and of course, prospects for promotions whether you chose to work in the industry or as the owner of your won desktop publishing business." (goal orientation)

In addition, Nwagbara a) removed non-instructional graphic images, b) condensed time between the narrators and c) eliminated or reduced the time between illustrations of the computer screens to result in two versions of the lesson that were both approximately 35 minutes in length.

For this study, text versions were prepared from Nwagbara's tapes. The text of the print versions was prepared by transcribing the narration from the videotapes. Two undergraduate students viewed the videotapes and read the text versions to identify visual images that they believed to be important to the text. Based on their recommendations, 35 images were digitized from the videotape and added to the text to provide interest and illustrate key points. For example, the text booklet begins with a series of images created using desktop publishing packages. Visual images of the "speaker" accompany the testimonials. And finally, the text versions include numerous images of the computer screen. The verbatim transcription was modified slightly for the print version. When the narrator makes statements such as "now you see" , the text version makes reference to the appropriate figure (in Figure 1, you see..").

Text versions were analyzed to ensure that they were equivalent to the videotaped versions. One by one, four graduate students in instructional design independently reviewed the text and video materials. Each student reviewed the regular text and video versions together, then the motivationally enhanced materials were reviewed together. As differences were identified between text and video versions, revisions were made to the text version. After two rounds of revisions, two reviewers agreed that the text and video versions were equivalent.

Assessment measures

Self-report questionnaire: The self-report measure of effort was created by modifying questions used by other researchers (Salomon, 1983b; Salomon & Leigh; 1984; Sherman, 1993). When Salomon's questions were used in a previous study with college students, the instrument only had Chronbach's alpha of .55 (Cennamo, Savenye, & Smith, 1991). Beentjas and van der Voort (1993) reported alphas of .60 to .64 when using similar questions with children. Thus, the instrument was modified in an attempt to increase the reliability of the instrument. Four of the questions were modifications of questions used by Salomon (1983b, 1984) and five questions were modifications of questions used by Sherman (1993) who reported a Chronbach's alpha of .69 for his mental effort questionnaire. Participants were asked to respond to questions such as "While reading the booklet, I concentrated hard on what was shown in the pictures." "The lesson made me think very hard." "I tried hard to understand the information presented in this lesson." Participants responded on a 5-point Likert scale which rated responses from "Strongly Agree" (5) to "Strongly Disagree" (1). In this study, the questionnaire had a Chronbach's alpha of .78 , indicating an acceptable degree of internal consistency (Borg and Gall, 1983).

Additional questions on the self-report questionnaire gathered information regarding participants' gender, previous experience with Macintosh computers, experience using desktop publishing software, and other demographic information.

Secondary task measure. The secondary task measure consisted of a computer program that presented an audible beep at random intervals then measured and the time between the beep and the moment when the participant clicked the mouse button in "tics" (a tic is equivalent to 1/60 of a second). During the practice phase, participants received seven practice beeps randomly generated in 10 to 30 second intervals. By averaging the seven practice response times, a baseline response rate was established.

During the actual use with instructional materials, participants responded to a beep randomly generated over intervals ranging from 30 to 90 seconds. Secondary task reaction times were calculated for each student by averaging the response time for each participant engaged with a lesson. Consistent with a procedure used by another researcher (Grimes, 1990), responses that were more than three standard deviations from the individual's mean were ignored for analysis. For example, if a participant failed to respond to a beep or responded after a much longer interval than usual, that particular score was eliminated from the final average score.

Post-test. The post-test consisted of a cued recall test, where students wrote down all they could remember about topics presented in the lessons. Participants were first asked to recall the ideas that impressed them most. The next five questions corresponded to the five major topics of the videotape. Participants responded to questions such as: " In SuperPaint, what tools do you remember and what were their uses?" and "What steps would you follow to create a news letter with a page-layout program?" Finally students were provided with the opportunity to list other information they recalled from the lesson ("What else do you remember from the lesson?")

A scoring key was developed that categorized responses to the post-test. The primary researcher and two research assistants (a graduate student in instructional design and an undergraduate education student) each reviewed 15 recall post-tests and clustered responses that seemed to be of a similar type. Responses seemed to directly recall information presented in the lessons, make inferences based on the information presented in the lessons, summarize information that was presented in the lessons, or evaluate the lessons. Differences in coding responses among the three individuals were discussed and coding categories were finalized. The final coding categories consisted of recall responses (this software leaves room to correct mistakes, I can design my own letterhead), inferences (it seemed easy, it seems convenient to use), and summary statements (there were different photos of parts of the computer, I remember the letters from people in the industry). Evaluative comments (the information was presented in good form; I was falling asleep) were not coded. The two research assistants then coded 15 other post-test using the coding scheme. After finding an acceptable inter-rater reliability of .97 between the two scorers, the tests were scored by one of the research assistants using the scoring key. Participants received a recall score, inference score, summary score, and total post-test score.

Procedures

All sessions were held in a computer lab which contained approximately 40 computers. Groups using the secondary task measure had a demonstration of the data collection program and practice with the program. During the practice session, a baseline measure of reaction time to the secondary task was collected.

All participants received either a motivationally enhanced videotape, "standard " videotape, motivationally enhanced print booklet, or "standard" print booklet. All learners were asked to read or view the lesson to learn as much as possible about the topic of the lesson. Participants in four of the eight sessions were asked to respond to a secondary task while attending to their lesson. They were informed that their primary task was to learn as much as possible from the lesson and also to press a key on a computer keyboard as soon as they heard a beep. Participants participating in the secondary task sessions wore earplugs to avoid sound carrying throughout the room.

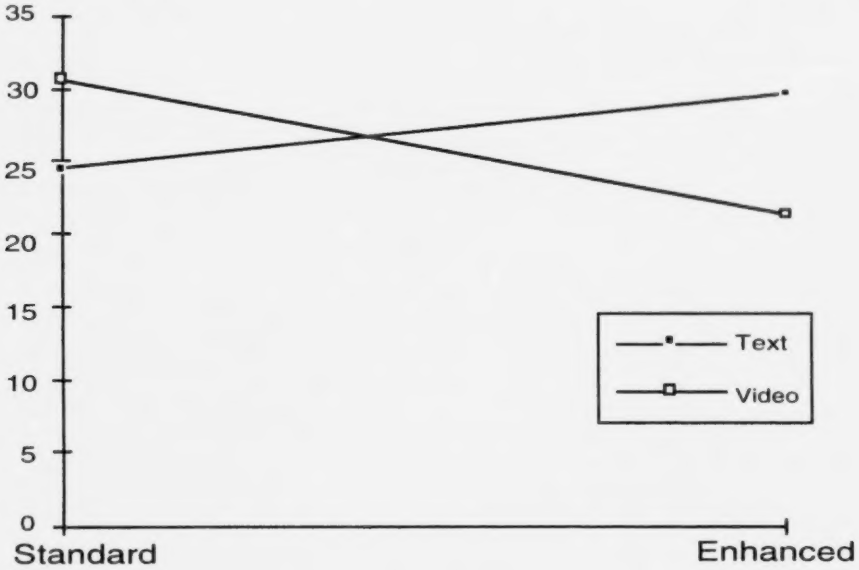
Participants receiving one of the videotaped versions viewed the lesson as a group from a large video monitor placed in the front of the room. Participants receiving the text versions read the lesson at their own pace from individual booklets. Following completion of one the four versions of the lesson, all participants completed the mental effort questionnaire. Finally, all participants completed the post-test, then created a logo and letterhead using the software demonstrated in the lessons. The participants were provided an opportunity to apply the skills demonstrated in the lesson to create a logo and letterhead; however, these products were not analyzed.

Results

Multivariate Analysis of Variance (MANOVA) was used to determine if there were significant differences among the eight groups for post-test and self-report mental effort scores. The analysis indicated several significant effects.

Interaction between media and version for post-test scores. The interaction between media (text or video) and lesson version (standard or motivationally enhanced) was significant, F (2, 107) = 4.37, p=.01. Univariate analysis indicated that the interaction effects were caused by significant differences among groups on the post-test scores, F (1, 108)= 8.38, p=.005. An examination of the means (see Table 1) revealed that post-test scores were higher for the standard version of video (M= 30.58) than the motivationally enhanced version (M= 21.23) , and higher for the motivationally enhanced version of text (M=29.64) than for the standard version (M= 24.49). (See Figure 1.)

Figure 1: Mean Post-test Scores



Mental effort assessment condition and recall scores. There were also significant differences in the post-test scores between groups who responded to the secondary task measure of effort and those who only responded to the mental effort questionnaire , F (2, 107)= 4.10, p=.02. Univariate analysis revealed that the significant difference was due to significant differences in achievement test scores, F (1,108) = 6.71, p=.01. Participants who responded to the secondary task while reading or viewing the lesson received significantly lower scores (M= 23.33) on the post-test of cued recall than those participants who only responded to the mental effort questionnaire after the lesson (M= 28.70). (See Table 1.)

Table 1: Post-test means

	standard text	enhanced text	standard video	enhanced video	TOTAL
Secondary task	**23.94**	**27.67**	**23.11**	**15.75**	**23.33**
	10.80	9.53	8.77	11.60	10.66
	17	12	9	8	46
Questionnaire	**25.00**	**30.76**	**34.53**	**24.36**	**28.70**
	13.24	12.17	12.98	13.36	13.29
	18	21	17	14	31
Totals	**24.49**	**29.64**	**30.58**	**21.23**	
	11.95	11.23	12.77	13.16	
	35	33	26	22	

Effect of media on mental effort scores. MANOVA indicated a significant effect for media, F(2, 107)= 6.83, p=.002. Univariate analysis revealed that the significant effect was due to differences among groups on their responses to the mental effort questionnaire, F(1, 108)= 11.78, p=.001. Students who received the text version of the lesson reported spending significantly more effort (M=29.53) in the lesson than those who received the videotaped version (M=26.23). (See Table 2.)

Table 2: Means on Mental Effort Questionnaire

	Text	Video
Means	29.53	26.23
SD	5.59	4.52
N	68	48

Note: Possible scores ranged from 9 to 45

Secondary task data. Initially, Analysis of Variance was used to analyze differences among group means for baseline reaction times collected during the practice session. There were no significant differences in the baseline reaction times among groups for media, F(1, 42) = 1.43. p=.24, lesson version F(1, 42)= .08. p=.78, or the interaction between media and lesson version, F(1, 42)= .31, p=.58. Since there were no significant differences among groups for the baseline reaction times (see Table 3 for mean scores on practice task), Analysis of Variance was used to determine differences among group means for reaction times to the secondary task. The interaction between media and lesson version was significant, F(1,42)= 4.17, p=.047. There also were significant differences among groups for media, F (1,42)= 7.28, p=.01, and lesson version, F(1,42)= 11.39, p =.002. An examination of the group means revealed that reaction times for those who received the video versions were significantly longer (M= 78.13) than those who received the text versions (M=55.38). In addition, the reaction time means for those who received the motivationally enhanced versions of the lesson (M=78.33) were significantly longer than those who received the standard versions of the lesson (M=52.59). (See Table 4 for means for secondary task.) Although the analysis revealed a significant interaction between media and lesson version (see Figure 2), an examination of the means indicates that the effects of media and lesson version was much stronger than the interaction. The significant interaction effect appears to be caused by the larger difference in reaction time scores between the standard video group (M=56.27) and the enhanced video group (M=102.71) than between the standard text group (M= 50.65) and the enhanced text group (M= 62.08).

Table 3: Mean baseline reaction scores

	Text	Video
Standard	43.62	47.76
SD	14.24	18.05
n	17	9
Enhanced	41.84	53.24
SD	27.50	25.45
n	12	8

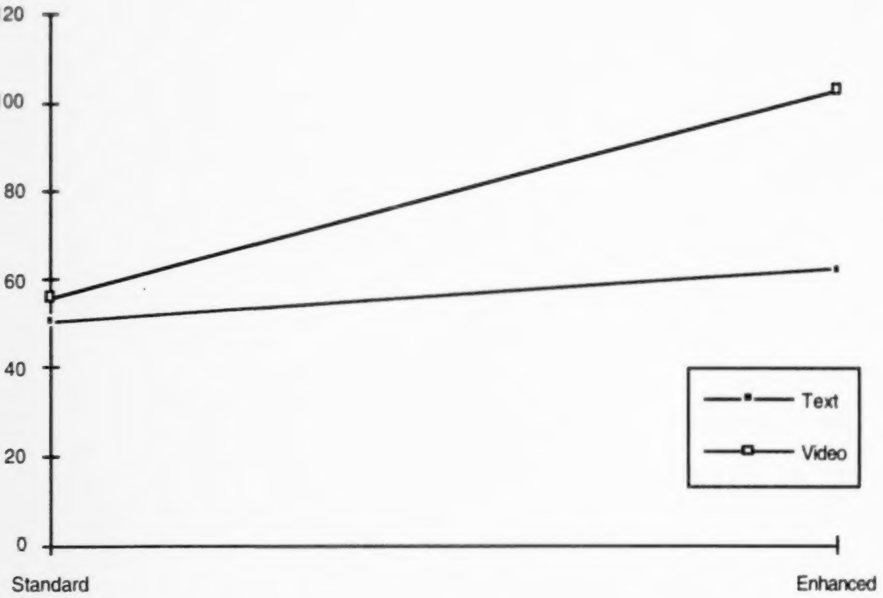
Note: reaction time measured in "tics", equivalent to 1/60 of a second

Table 4: Mean reaction times to secondary task

	Text	Video	Total
Standard	50.65	56.27	52.59
sd	18.68	23.83	20.31
n=	17	9	26
Enhanced	62.08	102.71	78.33
sd	34.42	36.79	40.02
n=	12	8	20
Totals	55.38	78.13	
	26.41	38.04	
	29	17	

Note: reaction time measured in "tics", equivalent to 1/60 of a second

Figure 2: **Mean Reaction Times to Secondary Task**



Correlations. Correlations among scores on the three dependent measures (post-test, mental effort questionnaire, and secondary task reaction measure) were tested using a Pearson's r test of correlation. The correlation between reaction time means on the secondary task measure and the scores on the self-report of mental effort were very low, r=-.05, p=.61 (N=46). Likewise, the correlations were low between post-test scores and responses to the self-report measure of effort r=-.069, p= .46 (n=117). The correlation between post-test scores and the secondary task response times was somewhat higher, r=-.28, p= .056 (n= 46) but in a negative direction. Correlations between the number of inferences generated on the post-test and scores on the mental effort questionnaire and secondary task measure were also low, with values of r=-.06, p=.79 (questionnaire) and r= .22, p= .52 (secondary task) respectively.

Post hoc analysis

Several analysis were conducted to determine whether participants' prior experience with desktop publishing or Macintosh computers may have influenced participants scores on the post-test and mental effort questionnaire. When prior experience with desktop publishing (experienced/ no experience) and Macintosh computers (experienced/ no experience) were used as independent variables in a MANOVA with mental effort and post-test scores as the dependent variables, there were no significant interactions, F(2, 103)= 1.20, p=.31, differences due to prior experience with Macintosh computers, F(2, 103)= 2.17, p=.12, or desktop publishing software (F(2,103) = .32, p=.73).

Discussion

The purpose of this study was to investigate a) whether college-age learners invest more effort in print-based lessons designed to teach the skills involved in desktop publishing than in video-based versions of the lessons, b)whether learners invest more mental effort in motivationally enhanced lessons than in "standard" lessons which lack motivational enhancements, c) the extent to which learners' self-reports correlate with their "on line" measurements of effort collected using a secondary task technique and d) the correlation between mental effort scores (from secondary task or self-report measures) and post-test scores on a recall measure.

As in Beentjas and van der Voort's (1993) study, the two measures of mental effort appeared to assess different things. Correlations between the mental effort questionnaire and the secondary task measure of effort were very low.

Despite the lack of correlation between scores on the mental effort questionnaire and the secondary task measure of effort, the findings of this study, conducted with college age students, are consistent with the results of studies conducted with elementary and middle school students. Like the younger learners who participated in Salomon (1983; 1984; Salomon & Leigh, 1984) and Beentjas and van der Voort's (1993) studies, college students who participated in this study reported that they invested more mental effort in learning from print versions of the lessons than in video-based versions on a self-report questionnaire. And like the younger learners who responded to a secondary task measure of effort in Beentjas and van der Voort's (1993) study, the college students who received the video-based lesson had significantly longer reaction times to the secondary task measure.

But the question remains: Which is a more valid way of assessing mental effort? If sensitivity to manipulations designed to increase the effort expended in the lesson is used as an indictor of the most valid measure of mental effort, then the secondary task measure may be superior. Using this means of assessing mental effort, participants spent more mental effort in reading and viewing the motivationally enhanced versions of the lesson than in the standard versions.

However, the results of this study indicate that the secondary task measure of effort interferes with student learning. For students who responded to the secondary task while reading or viewing the lesson, overall achievement was lower than for the other groups. Constant response to the secondary task may have interrupted their concentration just enough to disrupt the learning process.

In addition, there appears to be very little relationship between learner's achievement test scores, as measured by a test of cued recall, and the extent to which learners are cognitively engaged in the lesson, as measured by a secondary task technique. Likewise, there appeared to be very little relationship between learners' achievement scores and their perceptions of the mental effort they expended in processing the lesson as reported on a self-report questionnaire. However, these results are consistent with the low correlations between achievement scores and mental effort found in Beentjas and van der Voort's (1993) research with younger learners.

Of course recall depends not only on the extent to which learners concentrate on, process, or elaborate on the materials but also on their ability and willingness to retrieve the information (Driscoll, 1994). Participants may have lacked motivation to succeed on the achievement test, as course credit was awarded for participation in the study regardless of scores on the achievement test.

Keller (1983) also reminds us that achievement scores reflect a variety of factors other than the extent to which learners' expend effort in processing a lesson. He (1983) suggests that effort, rather than performance, is an indicator of motivation. Although participants who received the motivationally enhanced videotape expended more effort in the lesson, as measured by a secondary task technique, than those who received any other version, recall scores were lowest for those who received the motivationally enhanced videotape.

The overall intent in adding "motivational enhancements" was to increase the personal relevance of the materials (Nwagbara 1993), theoretically increasing the mental effort expended on the materials and achievement scores. However, the addition of motivational aspects may have "backfired". With the addition of motivational enhancements, learners may have had a difficult time distinguishing relevant information from irrelevant information. For example, learners who received the motivationally enhanced videotape may have been thinking about how desktop publishing could enhance their lives and missed information necessary for success on the recall test. Perhaps increased cognitive engagement, especially in response to video, resulted in lower achievement scores. As learners took the time to elaborate on the information presented in the motivationally enhanced videotape, they ran the risk of missing critical information due to the constant stream of visual and auditory information presented via video. Although learners who received the standard version of the videotaped lesson recalled more information than those who received the motivationally enhanced video version, learners who received the motivationally enhanced version in print form recalled more information than those who received the standard version of the print lesson. In addition, learners who received the motivationally enhanced print version had longer reaction times to the secondary task, suggesting greater mental effort, than those who received the standard print version. When learning from print, readers may take time to elaborate on the content of a lesson without "missing" critical information, due to the individual's control over the pace of their reading. This study provided no information on the nature of thoughts that may have occurred during the lesson. Future research using a "think-aloud" protocol may provide additional insight as to the cognitive processing that occurs while reading or viewing a lessons.

At minimum, there is a complex relationship between effort and achievement. In some studies, longer reaction times to a secondary task have paralleled less achievement (Lang, et. al., 1993; Reeves, et. al., 1985, and others); however, in other situations, increased effort paralleled increased achievement (Grimes, 1990; Britton, Glynn, Muth, & Penland, 1985, and others). Other times, more or less effort made no difference in achievement (Britton, Glynn, Meyer,

& Penland, 1982; Reeves, et. al., 1985). Does the secondary task technique and achievement tests the simply measure different things? The low correlations between learners' post-test scores and their reaction times to the secondary task appear to support this idea.

Future researchers may need to decide which is important to them: Effort or achievement? Does effort matter without achievement? Does achievement matter if learners are cognitively engaged and expending effort in learning? It may not be useful to use the secondary task technique to determine if manipulations increase the amount of effort invested in learning from materials in situations where the major goal is achievement.

Additional problems in using the secondary task measure of effort remain. Large standard deviations in scores are common when using a secondary task measure of effort. Due to the small number of students in this study, and the large standard deviations, the results of this study should be replicated with a larger number of students to increase confidence in the findings. In this study, it was possible to hold the class in a computer lab to avoid the appearance of a laboratory setting because the subject matter of the lessons was computer skills; however, researchers must consider that the use of the secondary task measure requires a laboratory like setting, where participants have access to the data collection equipment. In addition, there is a great deal of variability in the way researchers score and analyze data from the secondary task. If investigations of ways to increase the effort invested in video-based materials are to continue, the search for techniques to accurately assess the effort expended in the lessons continues to be an important area for further study.

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Title:

The Effects of Font Size in a Hypertext Computer Based Instruction Environment

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Some of the elements instructional designers must consider when designing screens for computer based instruction (CBI) include legibility, readability, and particularly font size. These elements are also factors that influence the comprehension and speed with which people learn (Grabinger, 1992). Although Grabinger proposes that no single element promotes learning more than another; the combination of these elements on the computer screen affects learning more than any single element. The contribution of font size in the development of CBI deserves investigation. The purpose of this study was to determine which size font is most effective for computer based instruction users.

Several research studies were conducted between 1885 and 1963 on the legibility of print based information. Tinker (1963) reported that no single method of measurement is adequate for determining the legibility of print in all kinds of typographical setups. Tinker provides several guidelines, based on the research prior to 1963, for the optimal legibility in print materials. These guidelines include (a) leading (space between lines) has an important effect on the legibility of type, especially in fonts smaller than 12 point and (b) font sizes between 8 and 12 points are acceptable. Eleven point font is the best size for reading speed and comprehension.

Many of the recommendations offered in the literature lack research support. One example is the recommendation of Felker, Pickering, Charrow, and Holland (1981) of 8 to 10 point font for the printed page of documents, and 14 point font for headings on documents. These authors reported the most effective font size should be easy to read and pleasing to the eye but offered no real evidence of what constituted ease of reading and what is pleasant to the eye.

A review of literature revealed very little direct research on computer font size. Similarly there was only limited research concerning font size for television screens. A television screen is an interface similar to a computer monitor but there are some major differences. These differences are television is not typically used for extensive reading, the viewer to screen distance is usually greater than the typical distance of one to three feet for a computer screen, and the resolution and the physics of screen refresh for a television screen is different from a computer screen.

Although the television research results do not apply directly to this study, some of the techniques and concepts from this research do apply. One of these is the more general "subtended angle" approach rather than trying to identify specific fonts for specific distances. Nevertheless, this study had a different medium and different tasks to study

With the advent of television, researchers began studying the legibility of characters on television screens. Smith (1979) showed a proportional width font is significantly better for recognition of words on TV screens than a non-proportional font. Research shows that character size ranging from 10 to 24 minutes of vertical arc is best for legibility on television screens (Shurtleff, 1967). Minutes of arc refer to the angle defined by the top of the character, the eye, and the bottom of the character. This angle is the subtended angle.

Shurtleff (1967) reported on legibility and symbol size on television screen in a review of literature that gave guidelines for accuracy of reading to occur. The examination found that viewers required a visual size of between 12 and 15 minutes of arc and vertical resolution between 8 and 12 scanning lines per symbol height.

Legibility involves perceiving letters and words, and the reading of continuous textual material. In the final analysis, optimal legibility of print is achieved by typographical arrangement in which shape of letters and other symbols, characteristic word forms, and all other typographical factors such as type size, line width, leading, page layout, and density are coordinated to produce comfortable vision, and easy rapid reading with comprehension.

Computer technology is rapidly becoming a component in training and education. People are using computers to learn new concepts and reinforce previously learned cognitive and motor skills. One such issue of interest is the legibility of the text on the computer screen. Legibility affects several aspects of learning, including the reading speed of the user and the comprehension of the information by the user (Tinker, 1963). Therefore, the legibility of the text on the computer screen is an item of importance to designers of computer based instruction.

Several authors (Heines, 1984; Hooper & Hannafin, 1986; Criswell, 1989) provide guidelines for optimal font size, leading, blank space, and line justification on computer screens. These guidelines are similar across the literature and are as follows: font size for computer screens should be 10 or 12 point, leading should be 15% of the character width, and left justification should be used, leaving the right edge of the screen jagged (Brockman, 1990). There is some difference in opinion about the recommended length of the line, with Hooper and Hannafin (1986) recommending up to 80 characters per line (the entire screen width) and Brockman (1990) and Merrill (1982) recommending that white space be left on the edges of the screen. While these guidelines are useful for designers of computer based instruction, there is little research using computer screens to support these guidelines. This study investigated the relationship of font size, comprehension, and user preference.

One aspect of legibility is the font size of the text displayed. While there is research relating to font size for printed information, little is available on font size as related to legibility when text is displayed on the computer screen. There are guidelines provided for use of font size on computer screens, but these guidelines tend to be based on print research (Hooper & Hannafin, 1986).

Giddings (1972) conducted a legibility experiment in an effort to determine optimum height for characters under particular conditions. Giddings' experiment attempted to find suitable sizes for words and numbers appearing on a directly viewed CRT. The results indicated that differences were found in the legibility of 6 letter words and single digits. Giddings reported that this may be due more to the informational content of the words and digits than their fundamental nature.

Snyder & Taylor (1979) conducted similar research concerning: font size and dot luminance of alphanumeric characters in comparison to recognition accuracy, response time, tachistoscopic recognition, and threshold visibility when presented in a non-contextual form on a CRT display. Tachistoscopic recognition refers to the length of time a display remains on a viewer screen. Threshold visibility pertains to the distance at which a viewer can recognize characters on a viewer screen. Findings indicated accuracy improved as font size increased and regressed as distance increased. The effect of higher levels of luminance was greater accuracy for the smaller character sizes and the further distances from the display screen. Response time increased as character size decreased and viewing distance increased.

Further, increases in luminance improved tachistoscopic recognition accuracy more for the smaller character sizes than larger. No significant findings were produced for threshold visibility. The conclusion by Snyder & Taylor (1979) was that characters less than 4.79 mm in height at a viewing distance of 1.5 m will significantly reduce legibility.

Similar research by Beldie, Pastoor, & Schwarz (1983) examined the question: Are variable-matrix characters more legible than fixed-matrix letters on readability, error identification, and the ability to locate the position of the target word on a CRT screen? In this experiment, fixed width characters occupied the same amount of horizontal space. Variable width proportional characters occupied differing width spaces depending on the character. Variable width characters such as "i" occupied less horizontal space than "w." The findings suggested that a proportional width font, even without serifs is significantly better for recognition of words on television screens. The authors recommended it for text displays.

Hathaway's (1984) literature review revealed interesting findings regarding letter size and density of display text. In a review of Smith's (1979) research, Hathaway examined letter size as it interfaced with legibility. Smith found that the viewers sitting 24 inches from a computer screen would need letters no larger than 3/16", and 94 percent of viewers would need letters no larger than 3/32" high from the same distance.

Readability

Comprehension and readability are important factors when designing screen layout and selecting the most effective size of font. Presenting lessons effectively on the screen is one of the central problems in computer based learning (Isaacs, 1987). Although font size is an important issue when designing computer screens, the instructional designer must consider typographic factors, organization factors, cueing factors, and control factors, in addition to the content (Grabinger, 1989).

Density of displayed text on a CRT impacts the speed with which readers comprehend material (Kolers, 1981; Jonassen, 1982; Hooper & Hannafin, 1986). Subjects read faster and more accurately with double spaced text than with single spaced text. Koler's findings indicated 80 characters per line resulted in faster and more accurate reading. Both the Jonassen, and the Hooper & Hannafin studies suggested that ragged right margins are easier to read than right justified lines.

Milheim & Lavix (1992) suggest using various type sizes and fonts to emphasize certain materials and variety. These suggestions include using bold type face for higher-level information such as titles or headings and using mixed-case letters for higher legibility and faster reading. Further, Bailey and Milheim (1991) recommend using only one font style per screen, text sizes larger than 12 point, and primarily using New York or Geneva fonts. Faiola (1990) suggests using screens that are consistent in size, color, and fonts for text, since more than two or three typefaces and/or sizes used within one screen can be disconcerting to learners.

Grabinger (1988, 1992) studied the effects of single and multiple dimensions on the computer screen in relation to learners' ability to read a computer screen (readability) and the understanding and learning that followed the viewing of the screen (study-ability). The purpose of this research was to identify constructs that could guide the design of computer screens used to display information in computer-assisted instruction, hypermedia, or on-line help applications. Grabinger reported comprehensibility is the combination of readability and study-ability. He further reported that single element research is extremely important in identifying the strengths, weaknesses, and potential problems of using specific attributes on CRT screens, such as font size.

Grabinger's findings indicate that screens that are organized according to functional areas with space, boxes, and lines, the use of headings, directive cues, and spaced paragraphs combined to present planned, controlled, organized, and structured appearances are the best for learning conceptual ideas. Further, visual interest is an important element. Grabinger reported that screens that are plain, simple, unbalanced, and bare are perceived as undesirable, while a moderate degree of complexity creates an environment that invited further exploration, in other words, motivation to continue reading.

On the other hand, in related research, Morrison, Ross, & O'Dell (1988) suggest that low density narratives promote better learning and more favorable attitudes on CBI lessons by reducing reading and cognitive processing demand of screen displays. The notion here is instructional designers, at the time of publishing, use the same design formats and teaching strategies traditionally incorporated in print lessons for developing CBI lessons. The rationale behind the study is that computers impose constraints on the display of instructional text because they offer considerably less flexibility than books. Computers limit the visible display to one page at a time, make backward paging for review more difficult, and limit the size of the page layout to 24 lines and 40-80 characters.

Pastoor, Schwarz, & Beldie (1983) conducted research on font sizes presented on standard home color television sets. Subjects performed five different tasks and rated the various character sizes. Their qualitative performance for all tasks was the same with each of the different character sizes; the amount of time necessary to complete the task, however, varied up to more than 20%. This would seem to indicate that none of the character sizes exhibited deficiencies that would exclude their use on color television screens. However, considering the time variance measured, and the fact that the larger font sizes decreased the time with which subjects could perform the tasks, the larger fonts appeared to be better for use on television screens. In all tasks, smaller character sizes produced poorer performance.

Research Questions

The purpose of this study was to find a font size, or sizes, to recommend for presenting text on a computer monitor. There are some obvious limits on the font size because of the discriminatory limits of the eye on the inability of the pixel resolution of a monitor to differentiate one character from another at extremely small sizes. There is also a limitation at which font sizes are too large to read. In the extreme, a 1000 point font would be almost 15 inches tall, much too tall to see even one letter on most computer monitors. Somewhere in between these extremes are the appropriate font sizes that users normally see on computer screens, such as 12 point, 16 point, and 24 point. The assumption is there is some determinable range of these font sizes that are readable, and a subset of the range that especially facilitates reading speed and comprehension. Finding the appropriate subset was the goal of this research.

Another question of interest is whether users might prefer one font size over another when reading for speed and comprehension. If there are several font sizes that promote optimal reading speed and comprehension, user preference might be a factor to help direct a font choice.

Methodology

Participants

The sample consisted of one hundred and sixty-three undergraduate and graduate students enrolled in an upper-level computer course entitled "Classroom Applications of Educational Technology" at a western university. The age of the volunteer subjects ranged from 20 to 46.

Subjects were randomly assigned to one of four treatment groups. Each treatment group received a different font size. Group one with 47 subjects used 10 point font. Group two with 37 subjects used 12 point font. Group three with 47 subjects used 14 point font. Group four with 32 subjects used 16 point font.

All subjects received a computerized version of the comprehensive section of the Neson-Denny Reading Test Form E (1991). The comprehensive section of the Nelson-Denny Reading Test consists of eight passages with one to eight paragraphs in each followed by four to eight questions. The passages were presented in a scrolling window on the screen. When the student completed reading the passage, the student moved to another screen and answered the questions on the passage. The student could not go back to the passage and review. This procedure was repeated for all eight passages.

The passages were presented on Apple Macintosh Centris model 610 and 650 computers with 14 inch display monitors. The passages were displayed with mixed case black letters on a white background in a Times Truetype font style. The font sizes were 10, 12, 14, or 16 point depending on the treatment group.

Procedure

The subjects received the following instructions before reading the first passages: (a) position themselves to a height with their eyes between the middle of the screen and the top of the screen, (b) seat themselves between 24" and 30" from the screen, and (c) enter their year of birth and await further instructions. After each student completed these tasks they were instructed about the passage content, number of questions, and the 15 minute time limit.

The subjects proceeded through the reading comprehension test at their own pace. The size of the text on the screen was randomly assigned by the computer program. Upon completion of the test, the subjects responded to a question about font size satisfaction. If unsatisfied, the subjects chose a font size from 10, 12, 14, and 16 point size.

The subjects were observed to determine those individuals not within the range of 24" to 30" from the screen. These subjects who were not within the range were noted in the experimental log.

Results

Dependent measures

There are four dependent measures: reading comprehension, satisfaction, preference, and distance from computer screen. Reading comprehension measured participants' reading comprehension of test passages. Satisfaction measured participants' satisfaction with assigned font size. Preference measured participants' preferred font size after the treatment. Posture indicates whether the students were inside or outside the optimal 2-2 1/2 feet from the screen during the reading of the passages.

Independent Measures

There are three independent measures: font size, age, and section. Subjects were randomly assigned to the font size groups by the computer program and were assigned sections based on which class they were in.

Design and data analysis

An ANCOVA was conducted using the dependent variable reading comprehension and the independent variables of font size and section. No reading comprehension differences were found for the main effects (F=0.35, p=.78 for font size and F=0.61,p=.77 for section) or interaction (F=1.23, p=.23) at a = 0.05. Likewise, the covariance of age did not effect the reading comprehension (F=0.13, p=.71). The ANCOVA source table is listed in Table 1.

Table 1

ANCOVA for Font Size by Section with Covariate of Age

Source	DF	Sum Of Squares	Mean Square	F
Font Size	3	21.64	7.21	0.35
Section	8	98.70	12.34	0.61
Font Size by Section	21	524.68	24.98	1.23
Age	1	2.67	2.67	0.13
Error	127	2584.52	20.35	
Total	160	3297.98		

A Chi-square was performed to examine whether a significant difference occurred between font size and satisfaction. A significant difference, shown in Table 2 (Chi-square = 74.204, p <.001) was found for satisfaction at a =.05.

Table 2

Chi-Square of Font Size by Satisfaction

	Satisfaction			
Font Size	No	Yes	Total	Chi-square
10	44	1	45	74.204
	97.78	2.22		
12	31	6	37	
	83.78	16.22		
14	22	25	47	
	46.81	53.19		
16	3	29	32	
	9.38	90.63		
Total	100	61	161	
	62.11	37.89	100.00	

A Chi-square was performed to examine whether a significant difference occurred between font size and preference (SeeTable 3). A significant difference (Chi-square = 51.81, p <.001) was found for preference at a =.05.

Table 3
Chi-square of Font Size by Preference

	Preference					
Font Size	10	12	14	16	Total	Chi-square
10	1	0	24	20	45	51.81
	2.22	0.00	53.33	44.44		
12	0	6	14	17	37	
	0.00	16.22	37.84	45.95		
14	0	0	27	20	47	
	0.00	0.00	57.45	42.55		
16	0	0	1	31	32	
	0.00	0.00	3.13	96.88		
Total	1	6	66	88	161	
	0.62	3.73	40.99	54.66	100.00	

A Chi-square was performed to examine whether a significant difference occurred between subject's distance from screen and font size. No significant difference (Chi-square = 4.78, p = 0.573) was found at a =.05. See Table 4 for the Chi-square results.

Table 4
Chi-square of font size by distance from screen

	Distance				
Font Size	Leaning Forward	Normal	Leaning Back	Total	Chi-square
10	14	31	0	45	4.78
	31.11	68.89	0.00		
12	8	28	1	37	
	21.62	75.68	2.70		
14	16	29	2	47	
	34.04	61.70	4.26		
16	10	22	0	32	
	31.25	68.75	0.00		
Total	48	110	3	161	
	29.81	68.32	1.86	100.00	

Discussion

The research hypothesis that an optimal font size for CBI design could be determined by our efforts lacked support. Reading comprehension scores did not show a significant difference. Most subjects needed more than the allowed fifteen minutes to complete the passages.

Results indicated a lack of satisfaction with the assigned font sizes of 10 and 12 points, however they were satisfied with font sizes of 14 and 16 points. Subjects preferred the 16 point size to the other font sizes. This result indicates a possible ceiling effect for font size at 16 points. From this we may infer that optimal font size recommendations of 10 - 12 point derived from print media research (Hooper & Hannafin, 1986; Tinker, 1963) are not adequate for CBI applications. Further our results conflict with those of Heines (1984) and Criswell (1989) which recommend a font size of 10 to 12 points. However, our results do agree with those of Pastoor, Schwarz & Beldie (1983) and Bailey and Milheim (1991) which favor larger font sizes.

This study had a number of limitations. The first group of subjects all received the 10 point font. This unexpected result apparently occurred as a consequence of the way HyperCard began its random number generation function. Subjects could have been randomly assigned in advance and not randomly assigned by group from the HyperCard random number generator. Legibility could have been more closely controlled. The reading test was expected to be completed within 15 minutes. However, only 8% of the subjects completed all passages and questions. Subjects should have been allowed more time to complete the passages and questions or fewer passages and questions should have been assigned. This study did not take into account other font styles or the use of double spacing.

The results of this study have two primary implications. Future research is needed because font size recommendations based on print media are inadequate, and the optimal size font for CBI applications is still not known. Future research should include the use of larger font sizes and take the above limitations into account.

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Title:

Image Maps in the World-Wide Web: The Uses and Limitations

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Introduction

The evolution of information delivery systems on the Internet into World Wide Web "browsers" like Netscape or Mosaic presents an exciting field for study in education as well as in business. Such tools are rapidly becoming a major interest to small and large business concerns (Ellsworth, 1995) and may soon impact the nature of education in profound ways (Perelman, 1992). Compared with text-based information system such as Gopher or Veronica, new graphical interface is one of the predominant features in the World-Wide Web. Everyday, hundreds of new graphics with new visual effects appear on the Web—a picture is worth a thousand words. However, Web designers should remember that a picture takes a thousand times more data than a word, which means it takes much longer to transfer, and often viewers are not patient enough to wait for the picture to load. This paper focuses on the image map, a key element in these new graphical interfaces, and the reactions of its viewers. Understanding the visual characteristics of the image map is critical to the design of effective information display and access tools. This study investigates nine different image maps selected from current home pages on the World Wide Web. These image maps were evaluated regarding their effectiveness by independent viewers and using criteria relating to visual literacy and hypermedia design. Research results are then discussed relative to visual, navigational, and practical characteristics.

World Wide Web

As recently as the middle of 1993, the delivery of hypermedia modules over computer networks was problematic. A mechanism was needed that would standardize structural principles for the delivery of such modules and that would be "within the economic reach of ordinary users" (Howard, 1993). By the middle of 1994, exactly such a mechanism, the World Wide Web, had become available. Now, the full spectrum of communication tools is available electronically. Today many resources of hypermedia-integrated text, graphics, audio, animation, and video are accessible across the World Wide Web (WWW).

The WWW is the fastest growing information tool on the Internet (Descy, 1994). Along with the rich multimedia communications, graphical web browsers also provide a very high level of interaction. Users can quickly jump to new, related information using interactive linking tools like "buttons," "hot words," or "image maps." These hyperlinks can connect users to new information resources on their own campus, within their own towns, or around the world with the simple click of a mouse button (Dougherty & Koman, 1994).

Image Maps

Graphics may be used to capture a viewer's attention, to hold interest (Grabinger, 1993), to supplement and reinforce textual materials (Lucas, 1991) or to provide organizational overviews of complex data (Grabinger, 1993), (Koneman & Jonassen, 1994). Likewise, in web browsers, graphics may just add visual interest, mark a simple link to related information, or indicate organized multiple links to a complex information set. In the WWW, these links are called hyperlinks.

A hyperlink is the connection between a word or graphic in an active browser view to another file anywhere on the World Wide Web (Hudak-David, 1994). A simple graphic hyperlink connects a single image to a single information resource (Figure 1). The image map (Figure 2) provides easy multiple choice access for web users. An image map connects a single, complex visual by multiple hyperlinks to a number of related information resources (Wiggins, 1994). A web browser recognizes when a user clicks a displayed "hot word" or "hot spot" and simply opens a connection to the pre-programmed uniform resource locator (URL - the Internet address of the desired resource). Currently, the image map is the most refined expression of this integration.

Figure 1. Simple Graphic Links to Single Data Sets. (http://vinny.csd.mu.edu/~howard/monet.html)

Figure 2. Multiple Links From One Image Map to Several Data Sets. (http://home.netscape.com)

Image Map Design Issues

Effective image maps require careful design with respect to visual and interactive aspects as they pertain to the users. User interface design for image maps touches on three broad areas: visual characteristics, navigational characteristics, and practical characteristics.

Visual Characteristics

Visually, as a graphic, an image map should be appealing. At the same time, it is important that an image map be easily recognized as a linking tool. There should be visual cues that tell users they are dealing with an image map. The visual content presented in an image map should also support a typical viewer's expectations relative to the information the graphic is supposed to represent (Lucas, 1991). For example, an image map for a university in Arizona would probably not be designed around an arctic theme.

The individual graphics and related "hot spots" within an image map should represent the natures of the key informational segments. For instance, a book icon is a good representation for library services. Hot spots within an image map should be easy to recognize (Lucas, 1991; Jones, 1995). Often, a change in the mouse cursor will cue the presence of hot spots. In other cases, maps or similar structural features suggest the possibilities of hot spots. An image map should be artistic and visually appealing but not too busy or cluttered (Lucas, 1991; Jones, 1995; Grabinger, 1993).

Navigational Characteristics

Navigation is the act of recognizing and initiating a hyperlink to new information. Navigational aids should, if desired by the viewer, permit returning to the starting point in order to investigate other possibilities. Back tracking and book marking are additional navigational aids to help clarify the structure of multiple paths and provide quick repeated accesses to pertinent information (Desberg, 1994; Jones, 1995). Image maps should help users build mental models of the underlying structure and inter-relationships of information resources (Lucas, 1991).

Navigational pit falls such as dead ends, endless choices, or links to non-existent resources should be avoided. Links to non-existent resources are troublesome given how frequently web pages change. Finally, "help" should be available on demand or when "non-hot-spot" areas of an image map are clicked (Desberg, 1994).

Practical Characteristics

Practical concerns consider the implementation or working characteristics of image maps. An image map graphic should not take too long to load (Desberg, 1994) and the special effects (image overlay, fades, fonts, extraneous visual information, colors, 3D, animations, video, backgrounds) should not clutter the display or frustrate the viewer (Desberg, 1994). It should be easy to tell what resources have been visited in the current session with the image map (Jones, 1995). A visual consistency (Grabinger, 1993) should tie the image map and its related information resources together, cueing the viewer that he or she has not branched off into unknown or unexpected territories (Lucas, 1991). The graphics and the related information resources should fit the target audience (Desberg, 1994).

Methodology

Development of Survey Questionnaire

Since there is no previous research about image maps, this research represents a pilot study directed toward developing an evaluation procedure. Starting with guidelines from several computer-related product checklists in the literature (Lucas, 1991; Desberg, 1994; Cates, 1992; Tolhurst, 1992), the authors developed a 20 question survey form addressing design issues based on visual, navigational, and practical characteristics. Two initial surveys, conducted as a pilot for formative evaluation, determined changes and clarifications needed in the questionnaire. Following the pilot, the scale of evaluation was changed from 1-4 (strongly disagree to strongly agree) to 1-10 (ten step scale from disagree to agree) in order to clarify and strengthen the differences in viewer opinions.

Initially, questions were stated so that a high numeric response indicated strong agreement. However, some questions became awkward to read in this format. For example, one question stated "I was not frustrated by the image map." The authors were concerned the question could be confusing because of the non-typical negative structure so a few questions were re-phrased on the survey form. This sample question was re-written "I was frustrated by the image map." In this format, a response of 1 suggests a good image map.

Of the twenty questions, eight questions covered visual characteristics. For example, the questions ask how easy the graphic is to recognize as an image map, how noticeable the hot spots are, or how appealing is the image map. The navigational aspects, using seven questions, ask how easy it is to move from page to page, how easy it is to return to the starting point, or if help is available. Five questions cover the practical concerns such as how long graphics take to load, how consistent the graphics are at a particular site, or if the image maps are frustrating.

Selection of WWW Sites

The evaluation scope was limited to educational or institutional home pages on the WWW. The Net Directory option of the web browser Netscape 2.0 was the sampling source using the category of education. Two sites from each of 36 sub-categories of the educational area were randomly selected by the authors. While examining the 72 site options, the authors selected image maps that covered the spectrum from difficult to facilitative for typical users. Nine sites, (Figures 3 through 11) representing visual, navigational, and practical image map characteristics, were selected for the final evaluation by independent viewers.

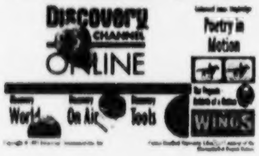

Figure 3. Discovery Channel (http://www.discovery.com/DCO/doc/1012/online.html)

Figure 4. Educom Image Map (http://www.educom.edu/)

Figure 5. ExCite Image Map (http://oberon.educ.sfu.ca:80/newhome.html)

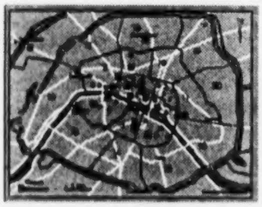

Figure 6. Map of Monument and Museums of Paris (http://meteora.uscd.edu/~norman/paris/Maps/MM)

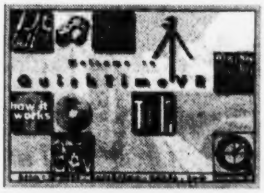

Figure 7. QuickTime (http://qtvr3.quicktime.apple.com/)

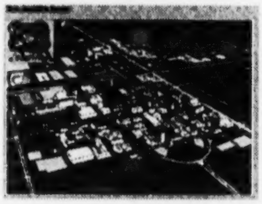

Figure 8. Texas A&M Campus Map (http://www.tamu.edu/test/map/map.cgi)

Figure 9. UCLA Image Map (http://www.ucla.edu/)

Figure 10. UWYO Image Map (http://www.uwyo.edu/)

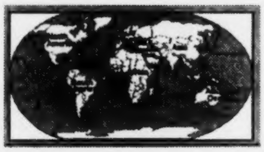

Figure 11. Virtual Tourist
(http://wings.buffalo.edu/world)

Independent Viewers

Nine viewers were involved in this survey. Most of them were graduate students taking instructional technology classes. Others were volunteers. They individually came to a computer station connected to the Internet and spent about one hour evaluating the image maps. Addresses of the nine sites and the survey form were given to the viewers and they usually decided which sites to evaluate out of the nine possibilities. Viewers' activities were observed by the authors during their evaluation time. Only two viewers finished evaluating all nine sites within an hour while one individual spent an hour and a half. Most of them evaluated four or five sites within an hour. Those who finished all nine sites within an hour were already familiar with the World Wide Web and image maps. Most viewers were quite new to the WWW and spent the first ten to fifteen minutes exploring. Those who were unfamiliar with the WWW were given some advice while exploring the image maps.

Results and Conclusions

Fifty surveys were collected from nine viewers. Each site was evaluated four to seven times by different viewers. For analysis, every question item has the same value system: the higher the score, the more positive the map characteristic. The 20 survey items were grouped into three categories: visual, navigational, and practical. Because each category reflects a different number of questions and a different number of viewer evaluations, the total score of each category was divided by the number of questions times the number of viewers in order to give a comparable weight to each category. Figure 12 shows the analysis of the data.

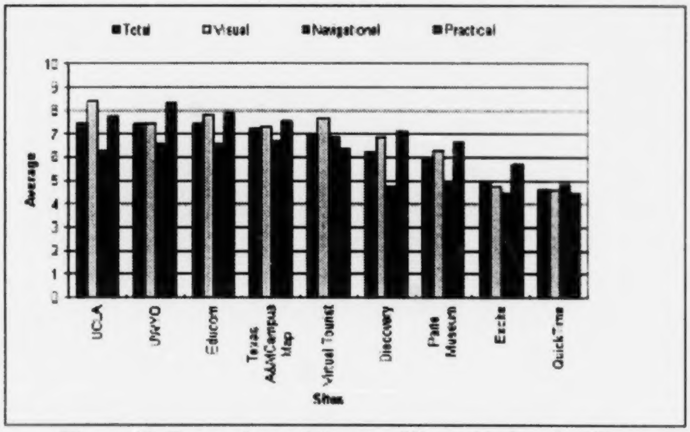

Figure 12. Comparison of Average Viewer Ratings by Site:
Overall, Visual, Navigational, and Practical.

Overall Rankings

Overall, the image maps of UCLA (Figure 9) and Educom (Figure 4) were selected as the best. In visual characteristics, UCLA and Educom also claim the top two rankings. From a navigational perspective, the Virtual Tourist (Figure 11), the Texas A&M campus map (Figure 8), and the Educom image map occupy the top three spots in a very close ranking. Finally, from a practical viewpoint, UW (Figure 10) has the highest ranking. The UW result is supported by an independent study of nearly 500 college web pages conducted at Columbia University, which also considered visual and practical characteristics (Johnson, et. al., 1995). Their study highly rated the UW web page for good presentation of general information.

Visual Perspective

There seems to be two conflicting elements at work in the visual analysis. Image maps can be very artistic and complex or rather simple. When viewers are looking for direction to information, they appear to prefer simple image maps. Even when viewers were asked how visually appealing a graphic was, they seemed to judge the degree of appeal by how easily they could get to information. If they could quickly locate hot spots in the image map and if the icons accurately represented the information, they seemed to prefer the graphic. The UCLA (Figure 9) and Educom (Figure 4) image maps, which ranked the highest, both use a simple and well-grouped layout.

In Grabinger's study (1993), simplicity is one of the important factors in computer screen design. Besides simplicity, Lucas (1991), in a study about effective computer-learner interfaces, states that grouping has a very strong influence on commanding and focusing viewer attention. As counter-examples, Quicktime (Figure 17), Excite (Figure 5), and Discovery (Figure 3) present more artistically interesting image maps. However, these three all violate the rules of simplicity and united grouping. For instance, the Quicktime image map scatters hot spots all around the graphic which de-focuses or scatters viewers' attention and results in the lowest visual ranking. The Discovery and Excite image maps appear to override marginal grouping with a too complex image.

Navigational Perspective

Navigation deals with the mechanics of moving through the available information. Regarding navigational aspects, the Virtual Tourist (Figure 11), Texas A&M campus (Figure 8), and Educom (Figure 4) image maps were selected the best. These sites do not give the viewers many layers of choices. Thus, it is easy to link out in a single step and quickly return to the starting point. The high ratings for the Virtual Tourist and Texas A&M image maps may also be a function of the physical nature of the information they represent. Grabinger (1991) suggests that viewers prefer screens designed to closely reflect the content of the subject matter.

Practical Perspective

As to practical aspects, UW (Figure 10), Educom (Figure 4), and UCLA (Figure 9) ranked highest. Typically, these image maps are smaller and load quickly. Special effects are minimal. Consistency is a strong characteristic of these image maps and their related information pages. The linking pages have visual cues such as icons or graphics very similar to the original image map. These maps were also highly rated in visual criteria, suggesting practical characteristics may be correlated with visual characteristics. Artistic images, such as the Discovery or QuickTime image maps (Figure 3, Figure 7), tend to be large, complex and slow to load.

Discussion and Recommendations

This initial study presents a number of factors that appear to be important to effective image map design when a viewer's purpose is to locate specific information. In this instance, functionality is the most important aspect. Simple graphics that load quickly and clearly designate hot spots appear to be preferred by the viewers in this study. Viewers, particularly novices, also wanted some site-specific help available when navigating web sites. Figure 13 presents the authors' recommendations as a "quick guide" for designing effective image maps for informational purposes. The Educom (Figure 4) image map, which placed somewhere in the top three rankings in each category, is the best example of these recommendations.

There may be different design guidelines when entertainment is the purpose of the image map. There is an interesting tension between artistic and functional aspects of image map design. A web designer must consider the balance between the purposes served by the maps and the intentions of the prospective viewers. From this research, viewers seeking information want functional, simple maps but viewers "surfing the web" may pass over such simple maps for the more artistic and entertaining images. The challenge to the image map designer is to find the balance between artistic needs to catch the viewer and functionality to allow the viewer to find information quickly. This balance issue presents opportunities for future research.

"QUICK Guide"
for Functional Image Maps

- √ Use simple graphics
- √ Use smaller than larger image sizes
- √ Clearly define hot spots
- √ Use unified rather than scattered grouping
- √ Choose icons to accurately represent information
- √ Design image map to model the structure of information
- √ Use a minimal number of layers
- √ Limit the number of choices
- √ Include site-specific help

Figure 13. Summary Design Guide for Functional Image Maps

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Title:

Virtual Reality: A Dream Come True or a Nightmare

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"The soul never thinks without a picture." Aristotle (390 BC)

Since before recorded history, when people were sitting around, staring into the fire or relating their experiences, their mind would visualize thoughts or stories in terms that could be understood and processed. The human mind has always converted information into visual images to be encoded and stored in long term memory. People have learned primarily through visualizing since the time of evolution (Psotka, 1994).

For instance, when reading or hearing the word "pencil", one creates a mental image of a pencil. With the advent of virtual reality (VR) and virtual environments (VE), images play an even more important role within the realm of visualization by generating and immersing the user in both visual images and auditory messages. Seen through VR, the pencil once visualized, comes "alive" in many different ways, thus the visualization experienced becomes enhanced many times over.

Virtual Reality

Virtual Reality is an exciting new medium based on a concept which allows total stimulation of one's senses through using human/computer interfaces. It already has many applications in training simulators, nano-science, medicine, entertainment, electronic technology, and manufacturing. In the near future, it will have increasingly greater applications which are bound to impact all aspects of life. Its effect on society, through both what is developed through advanced technology and the very essence of Virtual Reality, in and of itself, is likely to cause a cultural change in society as did the motion picture or television industry.

Virtual Reality is still in its infancy and the ideal usability of this technology is sometime in the future. When comparing Virtual Reality with a medium such as television, one has to realize even though TV is only two dimensional and despite its perceived simplicity, it has an extremely strong immersive quality and influence over people, especially adolescence (i.e. the issue of television violence).

Virtual reality is designed to be as close to true three dimensional as possible and its programs require interaction from users, not just immersion. The effects this will have on individuals and society as a whole cannot be totally foreseen at this time. But, the implications of what effects it can have are beginning to surface and should be addressed while the technology is still in its infancy.

It has long been known that we perceive and learn through a variety of different mediums. Aristotle, in 350 BC, wrote about mediums used in perception:

> There has to be a naturally attached medium... The following problem might be raised. Let us assume that every body has depth, i.e. has three dimensions, and that if two bodies have a third body between them (environment) they cannot be in contact with one another... The problem, then is: does the perception of all objects of sense take place in the same way, or does it not, e.g. taste and touch requiring contact (as they are commonly thought to do), while all other senses perceive over a distance? The distinction is unsound; We perceive what is hard or soft, as well as objects of hearing, sight, and smell, through a 'medium', only that the latter are perceived over a greater distance than the former; that is why the facts escape our notice. For we do perceive everything through a medium; but in these cases the fact escapes us...we perceive because the medium produces a certain effect on us (Stevenson, 1995).

Thus, if our senses trick us in the real world, how far then can we be additionally "tricked" by this new medium without demonstrating some type adverse reaction to it. An example again would be television. It portrays motion , but in actuality, it is nothing more than a sequence of scanned lines presented in a manner as to create an illusion of motion. Coupled with this, is an illusion of depth by the placement of graphical objects which allows the watcher to feel "presence" or "telepresence" (a sense of being in another place).

The Physio-Psychological Aspects

Virtual reality or virtual environments are oriented primarily as a spatial and temporal medium. Once immersed in it, "our minds construct a closure to create the experience of inclusion" (Bricken and Geoffrey, 1994)". The VR industry is trying to achieve a true four dimensional environment (height, width, depth, and motion) that will assist in the functions of human performance on many levels. Even though touch/feel, sound and smell are being incorporated into this technology, the primary focus is on the visual sense. This dominant visual property of VE's requires the user to learn and to relate through cognitive, psychomotor, and affective processes that are relative to but dissimilar to the processes used in the real world. (i.e.: flying over rooms, walking through walls, lifting objects that are too small or too large, maneuvering in space while repairing equipment, or swimming with fish).

There is greater use of the visual senses in VR than in almost any other form of communication with "signing" being an exception. The very act of signing is truly four dimensional, totally spatial and greatly iconic. Oliver Sacks in his book, *Seeing Voices*, addresses the fact that the hearing impaired who sign have better perception and direction of motion than other people of their same age and abilities. (Sacks, 1989). This is most likely due to the way spatial cues are processed along with experience in processing in this manner.

In the virtual environment a user is able to accomplish normally unrealistic or supernatural tasks along with normal tasks. Uniquely, the larger numbers of these tasks are represented in the form of objects and /or icons, and they are manipulated with the movement of hands and fingers. This presents a similarity between signing and virtual environments. Perhaps the spatial and temporal processes that are used by the hearing impaired can be used assist a user in VR to adapt to uncommon events that, prior to entering the virtual environment, could not or did not exist, how an event or task in a virtual environment processed mentally and, in what manner in which it affects the user's emotions.

Another area of the VE is the spatial process the brain uses to encode and decode visual information received, what signals are actually received, and the response returned. In the Soviet Union it was not an uncommon practice to remove healthy eyes from blind people and use the eyes to restore other people's vision, which seems on the surface to be an acceptable practice. However, over a period of time it was noticed that many of the people who were blind, developed sleep disorders. It was then determined that these people could not see in the normal light wave frequencies, that the brain had been able to determine day and night through other frequencies or mediums being transmitted through the eyes before they had been removed. It could very well be that there are certain optical or near-optical stimuli that are present in VE's that may have less than positive influence on the user's performance.

Technology Transfer

The human brain processes information in a manner we don't fully understand at present. Physiologically we have yet to determine how, as well as where, different information is processed and stored in the brain. Visual cortical neurons that are sensitive to motion direction, vertical axis, horizontal axis, or opposing directions, and the method in which processing of the information occurs are examples of visual perception and processing questions yet to be answered. In the normal world, we orient ourselves to binocularly perceive the size and distance of an object, using pre-established mental conditioning (learned experience). We process this environmental information without consciously realizing what or how we do this. From their research on field of view (FOV) and other related areas, Joseph Psotka, US Army Research Institute, Sharon A. Davison, Catholic University, and Sonya A. Lewis, Howard University describe the problem:

The visual space has to be coordinated with the proprioceptive space of the eyes, head and hands. This has not always coordinated in virtual environments, nor is it easy to engineer, since the psychological cues for these spaces remain complex and poorly understood (Psotka. J., Davison, S., and Lewis, S.A., 1993).

Since virtual reality largely depends on spatial and temporal recognition, the proper positioning of "objects" within a virtual environment is crucial to achieving any degree of reality. In essence, the human mind is being tricked into its perception of the "objects" and their placement within VEs. Any three dimensional "object" is perceived to have six points of reference or centers of origin; i.e. a cube has a front, back, two sides, top and bottom. In order to determine the size and distance, there has to be a seventh point considered to be the "oneegocenter" [or central ego center], "egocenter", or individual view point.

Once all six reference points have been established, then a perceived size and distance can be assigned to that "object". This completed information is then encoded and stored in the appropriate storage area of the brain. From there this process is repeated with any other "objects" within the VE, one by one until they have all been categorized and stored. At this point the next scenario is processed and repeated until that task is completed.

Three dimensional motion in simulation has the original 6 points of reference that are moveable (front-back, up-down, left-right) as well as yaw (angular rotation on the vertical axis), pitch (movement in distance) and roll (3-dimensional rotation of an object). These are known as the "six degrees of freedom" of movement. The seventh point or the point of observation is also required to perceive and define the object.

Technology vs. Performance

Virtual environments are designed in a way for the user to feel "presence" within that environment. Presence is "...the suspension of disbelief which permits us to share the digital manifestations of fantasy (Bricken & Geoffrey, 1994)." If the VE is not precisely adequate for the user, then there can be adverse effects on the user. For instance, if the binocular balance (equal recognition between both eyes) or the viewing point is not exact, the user may experience motion sickness or other manifestations can occur (Psotka, Davidson, & Lewis, 1993). If the proper balance between the vestibular and visual systems are not met, then the equilibrium of the human autonomic system can produce undesired symptoms such as dizziness, upset stomach, headaches etc. Even certain frequencies of sound can produce undesired effects, with some known to trigger epileptic seizures. Bruce Gil of Viewpoint Datalabs International stated that a warning notice is placed on certain VR arcade games to alert people with epileptic tendencies (personal communication, July 1994).

Among the known affects reported on this new human computer interface medium, is the possibility of flashbacks from certain "flight simulators" using HMD (head mounted displays) that produce strong effects as to cause the restriction on driving or flying for a period of time (Isdale, 1993). In some cases "flashbacks" occurring some hours after spending hours in a simulator have nearly caused fatal automobile accidents (Office of Technology Assessment, 1994). Another study by the Endinburgh Department of Psychology (Endinburgh Virtual Environment Lab), found that after ten minutes of light exercise while wearing HMDs, 20 young adults displayed clear signs of binocular stress. Over half the subjects also reported symptoms of visual stress, such as blurred vision.

Other Problems to Address

It is widely believed by the year 2000, entertainment will dominate the largest share of the virtual reality market (Biocca, 1992). Shapiro and McDonald (1992) express concern that "heavy VR users" with less skills and knowledge in making sophisticated reality judgments, may get lost in the VR environment. The very essence of virtual reality generates responses which in turn stimulates emotions. Jaron Lanier, one of the founders of VPL Research (the company that patented the data glove) relates his view regarding virtual reality games:

> Also, there's a problem that it's (VR technology) sort of an enforced form of compulsive behavior. There is no doubt that all of us - and let's say adolescent boys in particular - go through a period where they are interested in killing things and aggression. But I think the point is if they do it in the play ground, it's part of a fluid process which continues to grow and change. But, if they get caught up in an interactive loop, in some sort of a simulation entertainment product, then they get stuck in and relive the same loop again and again (Shapiro and McDonald p. 163-164).

Virtual environments have many similarities to "in depth day dreaming". There is inclusion, immersion, closure and visual images. Comparatively speaking, if day dreaming can be considered as an escape mechanism, how much more intensive and in what manner will the onset of virtual reality "games" with their powerful and unnatural environments affect the participants? In a recent report on virtual reality, Daily, Howard, and Caudell (date unknown) express their concerns that "...we can expect the full potential of virtual reality to be compellingly hypnotic, especially for entertainment (p.23)."

Issues and concerns:

1) Shapiro and McDonald (1992) point out that research has not focused on reality judgments in virtual reality but instead on the media effects. They suggest that "Interacting with such an environment may often tax mental capabilities", and the more real the environment appears, the more likely "it becomes a mental challenge to make judgments about reality (p.104)." Just individual temperamental personality differences determines the extent of immersion an individual person experiences (Psotka, 1994).

Cornell, Bailey, and Bollet (1994) raise concerns related to the well-being of unsuspecting individuals who may experience dramatic and highly-dangerous side effects which impact mental stability. Is there danger to unsuspecting users through immersion in virtual reality and other similar experiences? What effect will immersion in this powerful medium have on those subseptable to schizophrenia, bi-polar disorders, claustrophobia, or other related impairments?

2) There seem to be no published studies in the combining of artificial intelligence (AI) with virtual environments. Already the industry has termed certain AI components as "V-actors", "V-extras", "V-experts", and "V-agents" to be used as separate "beings" capable of changing the environment within VR games (Hamit, 1994). These "entities'" purpose is to "work together to undertake tasks beyond the capability "of the players or any one entity. What effects will "entities" have on the perception and judgment of users in virtual environments?

3) Psotka, Davidson, & Lewis (1993) relate an experience they had with moving a user who was preoccupied in a VR "fish world" chasing a fish. They moved him slightly and his first perception was that it was done by an invisible force. They continue to say that his second confusion was that he could not be moved in VR by the real world. They observed that the subject's momentary confusion and disorientation lasted several seconds before he could orient himself, and this was in a simple scenario. They continue by adding "Could it be, that with practice we could become more adept at holding these two realities intact' synchronically? If anything, our experiences in VR are making it easier and easier to enter VR completely immersed, and easier to forget entirely our real world surroundings" .

What will be the long term effects on "heavy" VR or simulator users in relation to their perception and interaction with a real environment? If just after a few hours of "immersion" in a simulator can cause serious "flashbacks", how much time can one spend in a virtual environment without psychological effects?

4) We must consider the ramifications of Marshal McLuhan's concept of the message being the medium as it would apply to VR and VEs. Virtual Reality (or a virtual environment) is an extremely powerful psychological medium. Is Virtual Reality as a medium so great, that it overwhelms the training or task when it is being presented through virtual environments?

Conclusion

As with any new technology, there are uncertainties of its potential, uses, and control. Virtual reality with all its magnitude is certainly no different. As in other technological advances, problems will arise and will be resolved. However, it was the intention of this paper to focus on some current and potential problems so that they can be studied and resolved. The immersed user of this medium and any undesired effects of the medium should be the primary focus and not the medium.

It is our belief that the end products of VR/VEs are designed to help us. Medicine, psychological treatment for phobias, and simulations that hone one's skills are indeed useful, if not extremely important. However, minimizing the detrimental or unwanted aspects should be considered before releasing an application of technology just for the sake of the technology.

We reiterate, "If the medium...were a membrane separating us from the object...we should be relative to it in the same condition as we are to air or water in which we are immersed (Aristotle, 350 BC)."

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Title:

Creating Personal Relevance through Adapting an Educational Task, Situationally, to a Learner's Individual Interests

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Preface:

"Introduction to Computing (Cmpsc101)" is an undergraduate introductory course that enrolls roughly 1700 students per year from widely diverse nontechnical fields. For most students, "Intro. to Computing" is their only exposure to the Computer Science discipline. The students are taught to design, code, and test what are for an introductory course, fairly sophisticated programs, which are structured, modular, and thoroughly documented. This course meets most of the requirements for an introductory Computer Science course, as described in the American Computing Machinery "ACM '78" paper. "Intro. to Computing" is one of many undergraduate courses that deal with quantitative subject matter at an introductory level and that students are required to take as a general education requirement. Due to large class sizes, instructors of such courses often have difficulty involving students actively in the learning process during class time, let alone adapting course content to students' personal interests and goals in order to make learning more meaningful. Students, for the most part, retain the subject matter long enough to pass the final exam which results in inert, unprocessed, and therefore unusable knowledge. CBI (computer-based instruction) can play a key role in solving such problems by contextualizing the content of instruction to the most relevant and current interests of each student. By providing interestingly relevant contexts, and learner choice of context, the locus of control is placed with the student and not the instructor. This instructional strategy enables students to relate content to personal experiences and preferences and therefore construct personally meaningful knowledge that is usable and transferrable to new situations in the future.

Introduction:

Most college courses can be described as having an instructional core with supplemental features. For example, in one course the core might be the lectures, with text(s) considered supplemental and useful only to the extent that they elaborate on the materials covered fully in lectures. In another course, labs might be the core while lectures and texts would be peripheral. Introductory undergraduate courses are no different. Large college institutions refer to these courses as "service courses" due to the fact that students enrolled in them are non-majors to the discipline being taught, but are required to take them as foundational to their major, or as a general education base. Service courses are generally taught in lecture halls that seat anywhere from 50 to 600 (or more) students and the subject matter covered is usually domain general knowledge. Instructors typically use projection devices or movable blackboards as teaching aids, and spend most of the period lecturing from a platform through a microphone. Some of those courses offer small group "recitation classes" to help the students in understanding or applying the subject matter. This is where the "examples" and "applications" of the content are explained or demonstrated.

The format and teaching techniques described above have one thing in common: courses are organized in linear order from the instructor's point of view and therefore every student receives the same instruction at the same pace using the same context. One instructional certainty is that the way in which an expert organizes a body of knowledge is not the same as the way that a novice does (Glaser, 1985). Another instructional certainty is that what might be a relevant and meaningful context for one student is not necessarily relevant and meaningful to another. The list goes on. All to say... and this is hardly revolutionary... that the focus must be on the student's learning and especially on the diversity of ways in which students learn. However structuring a course around students' diverse learning styles and individual differences becomes very problematic in a large class. The purpose of this dissertation study is to show how computer technology can help in overcoming such constraints by adapting the content of "service courses" to interestingly relevant contexts and allowing the student to choose the most personally relevant context at the time of instruction. While this adaptive strategy does not cover many of the individual differences that impact learning, it follows a learner control format of providing learner choice of context, which can be modified or extended to provide learner choice of lesson sequence, pacing, content structure, and other instructional variables that are considered adaptive to cognitive styles and prior knowledge. This approach gives a sense of ownership of content to the learner and promotes relevancy.

Theoretical Framework:

Robert Yager (Yager, 1989) provides a rationale for using *"personal relevance"* (defined by Eisner (Eisner, 1985) as an orientation for the science curriculum which emphasizes the primacy of personal meaning for students by developing programs that focus on their interests and personal experiences) as the primary focus and organizer for planning a science curriculum in schools. He argues that personal meaning and understanding precedes *"social adaptation"* (defined by Eisner (1985) as an orientation for curriculum planning that focuses on societal concerns) of individuals making other orientations (Eisner, 1985) defines five basic orientations for the school curriculum: personal relevance, social adaptation and reconstuction, academic rationalism, technology, and development of cognitive processes) for curriculum planning in science inappropriate due to their inability to promote a useful understanding of the discipline and a positive attitude or desire among students to study more science. He goes on to argue that typical school programs that are planned by curriculum developers, textbook companies, and individual teachers, do not seem to take into consideration the student, his/her interests, motivations, and personal experiences. Yager believes that a *personal relevance* approach to designing a science curriculum would resolve such issues as well as past failures of science education. Eisner (Eisner, 1985) supports this argument by stating that students must have some investment in the learning experience for it to become educational. Students must actively participate and share in curriculum development in order to make real choices available otherwise "*schooling is likely to be little more than a series of meaningless routines, tasks undertaken to please someone else's conception of what is important*" (Yager, 1989). Eisner likens the *personal relevance* orientation to "open schools" (lack of domain structure) and to programs organized around student interests.

If one were to espouse the above approach, then structuring a science curriculum, or any curriculum, around students' interests and personal experiences is not an easy task. The unique and individual interpretation of educational tasks is largely dependent on prior knowledge and the construction and reconstruction of the activities that students engage in for experimental purposes (Renninger, 1992). Individual interest as defined by Renninger includes both the stored knowledge and the particular relation (value) of the individual with the task relative to other activities that he or she engages in. Since interest is expected to vary between individuals and therefore influence the way in which they act, a strategy is needed to identify individual interest and match the educational task to the particular interest in order to increase *personal relevance.*

Whereas Renninger operationalizes the definition of interest by emphasizing the contributions that individual differences bring to the understanding of an educational task (knowledge/value system), Hidi (Hidi & McLaren, 1990) takes a different perspective on how interest affects learning or cognitive performance and that is through the *interestingness* of the context or what has been termed by Krapp (Krapp, 1989a) as *situational interest.* The focus of situational interest is on the environment and the features or characteristics of the stimuli present in the environment, verses the individual and his or her personal knowledge and values. Interestingly, the interaction between personally generated interest (individual interest) and environmentally generated interest (situational interest) is crucial to both perspectives (Hidi, 1990; Hidi & Baird, 1986). A particular form of situational interest is known as text-based interest. Interest is elicited by using *interesting* analogies and examples in certain text segments, and through ideas, topics, and themes that are relevant to the educational goal. Research results on text-based interest can be described as increasing motivation and comprehension but not enhancing overall learning unless coupled with other organizers of text such as structural features (Hidi & McLaren, 1990).

Key Argument:

Building on both perspectives of interest, situational verses individual, the researcher proposes that the interaction between situational interest and individual interest is a crucial factor in promoting increased motivation, and effective knowledge acquisition and transfer. Individual interest in an educational task or activity will motivate the student to engage in the learning process, and situational interest will provide the authenticity and real world significance of the task to provide a meaningful experience and *personal relevance*. The key factor here is adapting the educational task, situationally, to students' individual interests. The question is then how do educators choose educational contexts that are relevant to students' individual interests and adapt the educational task situationally to those contexts?

Let's start by operationalizing the concept of individual or personal interests. Personal interests lie on a continuum ranging from internally generated interests to externally generated interests, with internally generated interests beginning with personal beliefs, values, and concerns, and extending to the surrounding environments and beyond (see figure A).

Figure A

See Appendix A of the 1996 AECT Proceedings

Personal Interests Continuum

Individual interests can be driven by one or many of the personal, social, or environmental structures provided in the above continuum but the affordances (optimal opportunities) that each of these structures provide, and the unique interaction of an individual with these affordances, will dictate the *most highly-valued* interest at a particular point in time.

There is also a certain degree of overlap among internally generated and externally generated interests and a ripple effect is created if one takes a circular view of the continuum. To illustrate, Lewin (Lewin, 1935) defines the life space of an individual as a mental sphere that consists of the person and the psychological environment that exists for that person at any given time. Life space is the extension of the individual from the personal dimension to the social and environmental dimensions and is dynamically influenced by the needs within each dimension and the interpersonal interactions among those needs. Personal interests therefore, *change*, based on the movement of the individual in the life space (see figure B).

Figure B

See Appendix A of the 1996 AECT Proceedings

Lewin's Visualization of the
Life Space of an Individual

Contexts for educational content can be created to match the personal, social, and environmental dimensions of the life space of an individual and students can freely select the most personally relevant context depending on their location on the "personal interests" continuum and the foreseeable affordances that a particular context might bring.

Creating Educational Contexts Based on Interest:

Herndon (Herndon, 1987) investigated learner interests as a variable that can enhance motivation in learners and incorporated students' interests in an instructional unit on how to solve conditional *syllogisms* (a form of reasoning in which from two given or assumed propositions called the premises & having a common or middle term a third is deduced). He collected data from an interest survey given to all the students that participated in the study and built the interests inventory using the most frequently reported learner interests. He used this inventory to structure the examples of the 'interests' version of the instructional unit and found that significantly more subjects in this group were willing to return to the task of solving syllogisms than the subjects in the 'no interests' version of the instructional unit. The interest survey was based on the work of Sarbin (Sarbin, 1964) who described human experience as an interaction of five 'ecologies' or facets of the environment within which the individual 'forms collections of highly valued interests'. The ecologies or environmental spheres according to Sarbin are: Self-Maintenance (objects and activities), Spatial (places), Social (persons), Normative (knowledge and skills), and Transcendental (ideas and beliefs). Five questions were asked in the survey that were derived from four ecologies. The questions asked for three favorite possessions, three things one likes to do best, three places that one likes best, three highly valued persons, and three things in which one has a valued knowledge or skill.

Selecting contexts for educational content can take on a similar process by conducting a survey on a subset of the experimental population that asks students to prioritize knowledge domains such as science, social studies, and/or humanities, from most interesting to least interesting based on their desirability as an educational context for introductory, quantitative subject matter. The domains will represent the personal, social, and environmental dimensions of the life space of an individual using the structures of the "personal interests" continuum defined above. For example, sociology might be a context that represents the social dimension and incorporates issues dealing with the family and the community. Daily life might be a context that represents the personal dimension and incorporates issues such as personal beliefs and well being. Fiction might be a context that represents the environmental dimension and incorporates transcendental or supernatural issues. An inventory of contexts can be included in the survey and contexts with high ratings will be identified as most relevant to students' interests. Educational tasks can then be contextualized to all or part of the selected contexts depending on the need and applicability of the particular course content.

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Let's suppose that six educational contexts have been identified as highly relevant to students' interests: science, daily life, education, business, sociology, and the arts. Computer-based instruction can present this inventory of contexts to students enrolled in an introductory course and students will be asked to select their most preferred context for learning the subject matter of that course. The content can then be contextualized to the most preferred context. This process can be repeated each time the student interacts with the instruction. Individual interest will be promoted through choice of context and situational interest through contextualizing of content. The resulting interaction will increase the valence (perceived challenges or possibilities) of the task and the student can then take advantage of such a learning strategy to construct meaningful knowledge and as a result transfer the knowledge to applicable and new situations in the future.

The interaction or contextual effect resulting from the above instructional strategy becomes more crucial when the educational task or content has a negative valence for a particular individual. The assumption here is that quantitative subject matter generally has a negative valence for non-technical students and a transformation in valence from negative to positive is what's being sought. This transformation can be realized by embedding the educational task in a context that becomes "personally relevant".

Contextualizing Instruction:

Preparing alternative context lessons and matching them to students' interests is a time-consuming task (Ross, McCormick, Krisak & Anand, 1985) that teachers are not able to perform particularly in undergraduate education due to large class sizes. One of the most powerful features of computers is their ability to adapt instruction to learner characteristics by individualizing lessons on predetermined instructional variables. It is important to distinguish here between adapting and individualizing instructional lessons. In the literature of instructional technology, individualizing instruction implies incorporating decisions about pacing, sequencing, and selection of content which is commonly known as "learner control" or "internal control" (Hannafin & Ross, 1984) stated that "learner control" or "internal control", is adaptive if students have the knowledge and motivation to make correct decisions about their learning needs). Programmed instruction is an example of individualizing instruction that is based on "program or external control" (Ross & Morrison, 1988). The learner is branched to the appropriate lesson segment depending on the evaluation of the learner's performance. Several criticisms of program-controlled instruction have been levied by critics including Hannafin (Hannafin, 1984), and Ross & Morrison (Ross & Morrison, 1988), concerning the accuracy of the designer's judgement on when and how to direct the branching process, and the reliability and validity of the evaluation criteria.

Adapting instruction is adjusting the educational task or activity to students' prior knowledge and needs or relating the instruction to students' goals and interests. It can be achieved through various instructional strategies one of which is adapting the content of the instruction to learners' interests and preferences (different situations) known as contextualizing instruction. *It is anchoring the lesson in an authentic context that promotes personal relevance.* If the learner perceives that significant personal needs are being met by the instruction then relevance will be increased (Keller & Suzuki, 1988), and the learner will be more motivated to engage in the learning task. This would facilitate the assimilation and integration of new knowledge by associating the task with familiar and personally meaningful events (Ross, 1983).

Another instructional strategy that claims to be adaptive and flourished with the onset of Computer Assisted Instruction, (CAI), is personalizing instruction. Personalizing instruction is incorporating personal information about the student such as birth date, names of familiar people, hobbies, and other specific events into the instructional lesson. Personalization of instructional material in most commercial software is a piecemeal approach to adapting the context to students' individual interests and can create a false facade of personal relevance which may result in shallow processing of the content rather than conceptual understanding and transfer of knowledge. Personalizing is adaptive only to the extent of providing *personal relevance* through recognizing individual characteristics and interests and not through contextualizing the task to individual interests.

The above adaptive strategies are necessary but not sufficient to create the appropriate balance between individual interest and situational interest. Contextualizing instruction in this study goes a step further by adapting the content to a personal, social, or environmental context that has real-world significance and an applied focus or goal. It anchors the abstract concepts of the educational task in a situation that has a theme and a goal. For example, let's assume that the most preferred context for learning statistics for a particular student is pop music. Instead of presenting the statistical concept of MODE as the score which has the highest frequency in a distribution, it would be presented as the number of weeks that Michael Jackson maintained his single hit at number one in the charts (presuming that he had the highest frequency amongst a group of artists during a specified time period). Other related content would be presented using the same theme. A goal would be to compute the percentile ranks of the artists' hits as they move up and down the charts. Embedding the content in a personally relevant theme and giving it an applied goal minimizes the problem of "disconnected knowledge" and maximizes the opportunity of learning "knowledge as information to be applied or used" (Perkins, 1992).

Foundational Research:

Several studies were done by Ross et. al. (Anand & Ross, 1987; Ross, 1983; Ross, McCormick & Krisak, 1986; Ross et al., 1985) to determine the effects of adapting the context of quantitative material to student interests and background as well as personalizing arithmetic material to elementary school children using computer-assisted instruction. Adapting instruction in the above research studies consisted of adjusting or matching the examples of the subject matter to identifiable student variables or needs such as prior knowledge, academic major, and individual interests.

In one experiment, preservice teachers were given a lesson on probability using three context treatments: abstract or non-adaptive, an education context and a medical context. The preservice teachers matched with the education context performed better than the abstract and medical contexts on immediate and delayed near transfer problems (context related problems), and better than the abstract group on far transfer problems (novel situations). Another experiment was conducted to validate the adaptive context strategy to students' background by providing nursing students with the same material. The results were equally effective. The group of nursing students that was matched with the medical context performed better on all learning outcomes. The bottom line was the relevance of the context to the subjects' interests. Ross et. al. (Ross et al., 1985) furthered the research on adaptive instruction by testing whether *individual-based context selection* (learner-adaptive group) was more advantageous than *group-based context selection* (standard-adaptive group). In the individual-based approach students were asked to rank-order (from most to least favored) four areas (education, medical, sports, and abstract) that were used as contexts for presenting word problems. Students were either matched with their most favored choice during instruction (learner-choice adaptive strategy) or their least favored choice (learner-choice nonadaptive). The group-based approach used a standard-adaptive strategy by matching an entire group of subjects to the context that represented their academic major (using two separate experiments, nursing majors were assigned the medical context and education majors were assigned the education context). The hypothesis was that a medical context would be more favorable to nursing majors and an education context more favorable to education majors and consequently more meaningful learning would occur. A standard-nonadaptive strategy was administered as a control in which the assigned group(s) received the word problems in an abstract context (the word problems did not reflect any real-world application of the mathematical concept under study). The results favored the adaptive treatments on a variety of achievement and attitude measures with particular positive effects on transfer measures in one adaptive group. *No differences were reported between the individualized and the group adaptive strategies*. The authors indicated that the homogeneity of each group and differences in prior knowledge may have contributed to those results. The authors also pointed out that the contexts for the learner-choice adaptive and standard adaptive groups were almost identical because nearly all the subjects in the learner-choice adaptive groups selected the same context as the standard adaptive groups. In a previous study, Ross et. al (Ross et al., 1985), reported similar findings and attributed the no-difference on achievement measures between learner-choice and standard adaptation strategies to yet another factor and that is the limitation of context options.

The above research findings clearly indicate the benefits of adapting context to students' interests but they do not clarify whether the benefits were due to the personal relevance of the context to the learner. The contexts provided in the above experiments were based on students' academic major and not on knowledge domains that could represent personal, social, or environmental dimensions of the life space of an individual. Individual-based selection and adaptation of most preferred context was not favored as a unique strategy but the overall posttest mean difference between learner-choice adaptive and learner-choice nonadaptive was 18.8 (78.3 - 59.5) versus 8.5 (69.4 - 60.9) for the group-based adaptive and non-adaptive strategies (Ross et al., 1986).

A contrast in the application of context to instruction was investigated in a series of studies by Bransford & Johnson (Bransford & Johnson, 1972). The studies provided evidence on using prior knowledge as a tool to aid comprehension. The major assumption was that *"contextual information is necessary for the ongoing process of comprehension"* and that prior knowledge must be semantically encoded (related to prior or familiar knowledge) to become usable and accessible in new situations. The experiments involved the interpretation of the underlying structures of abstract sentences and the treatments were varied using a Context Before reading the passage, Context After reading the passage, and No Context Before or After reading the passage. The context was provided using an appropriate picture. Other experiments used a topic for the passage to activate a suitable context. Results showed that using the Context Before (providing the context before the passage), greatly improved comprehension and recall scores. Bransford and

Johnson suggest that contextual cues must be present at input in order to aid comprehension. The data also provided evidence that students who were not provided with the context (picture or topic in this case) prior to reading the passage were actively searching for a situation to anchor the passage in. The topic and the picture helped the students activate semantic contexts of prior knowledge by functioning as a mnemonic device (Lachman et. al. (Lachman & Pompi, 1967; Lachman & Dooling, 1971) suggest that knowledge of the topic facilitates retention by functioning as a mnemonic device. Bransford and Johnson (Bransford & Johnson, 1972) however view the role of the topic as something more than generating associations and that is to aid comprehension through creating meaningful contexts of abstract information).

The above experiments provided context as an advance organizer to help relate incoming information to prior knowledge in a meaningful manner. Depending on the type of advance organizer, there could be several interpretations of the content. Even though the key issue was the timing of presenting the context rather than the choice of context, the effects of contextual content on knowledge comprehension were verified.

Renninger (Renninger, 1992) conducted a study on interest and mathematical word problem solving using a population of fifth and sixth graders where a total of 12 word problems, 3 with interesting contexts and 3 with noninteresting contexts at the student's mastery level, and 3 with contexts that were *identified interests* and 3 with contexts that were *identified noninterests* at the student's instructional level. In other words, the mastery level word problems were based on situational interest and the instructional level word problems were based on individual interest. The dependent variables were accuracy and type of error committed. Findings revealed that students were more accurate in completion of mastery than instructional problems. Individual interest and gender had a joint effect on the type of error committed. For example, boys made more error in setting up noninteresting problems (presumably because interest is more likely to assist in understanding these problems) and girls made more errors in setting up interesting problems (presumably because interest is more likely to be a distraction than an aid on these tasks). On a similar interest and reading study, students had an easier time engaging in (or being distracted by) contexts of interest than contexts of noninterest. Renninger's research seems to suggest that individual interest generates task engagement based on the challenges that students set and the kinds of questions with which they feel most familiar with, whereas situational interest is more spontaneous and can cause interest by surprise and therefore produce unexpected results in certain situations. Further analysis suggests that individual interest tends to have long-lasting effects on a person's knowledge and values while situational interest may have only a short term effect and marginally influence an individual's knowledge and values (Hidi, 1990; Hidi & McLaren, 1990). Renninger's research strengthens the argument that each type of interest has its own drawbacks and that's more of a reason why the interaction between situational interest and individual interest is crucial.

Purpose of Study:

Capitalizing on the significance of the effects of contextual information on knowledge acquisition and transfer, and the varied effects of individual interest and situational interest on promoting task engagement, the purpose of this dissertation study is to 'tease out' the confounding factors that dampened the effectiveness of individualized (learner-choice) adaptive strategies in the Ross et. al. (Ross et al., 1986) study by eliminating group-based standard adaptive approach, expanding the interests inventory of contexts based on identified students interests, anchoring the content of quantitative subject matter in the identified contexts, and allowing individual choice of context at the time of instruction. This study attempts to show that providing interesting contextualized choices will have a causal effect on personal relevance and knowledge acquisition.

Research Question:

Will adapting CBI of introductory undergraduate course content to a student's most interesting context, increase relevance, and facilitate knowledge acquisition and transfer, versus adapting to a student's least interesting context or non-adapting?

Subordinate Questions:

1. Will adapting CBI of introductory undergraduate course content to a student's most interesting context increase relevance of content?
2. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve attitude toward the content?
3. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve achievement on recall measures?

4. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve achievement on application or near transfer measures?
5. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve achievement on inference or far transfer measures?
6. Does the most interesting context for a particular individual vary from one lesson to another?
7. Is there an interaction between the context of the lesson and the context of the achievement measure?
8. Is there an interaction between the context of the lesson and the level of learning outcome being measured?
9. Is there a relationship between the student's academic major and his/her choice of context?

Methods & Procedures:

A pilot study was conducted to test the main research question above and some of the subordinate questions. This section will describe the design, the methodology and the results of the pilot study.

Pilot Study:

Design:

The design of the pilot study was a one factor quasi-experimental design with a pre-post measure on the dependent variable relevance and a posttest-only measure on the dependent variable knowledge acquisition and transfer.

Subjects:

The subjects were a heterogeneous group of undergraduate students enrolled in computer science 100, an introductory "service course" that familiarizes students with general computer applications (word processing, data base management, and spreadsheets). The subjects participated in this study as part of completing class assignments but were provided with an alternative assignment if they did not wish to participate.

Medium:

The instructional lessons were developed using authoring tools to produce computer-based instructional modules. The content, which was elementary statistics, was contextualized to eight domains: sociology, the arts, daily life, business, science, education, music, and fiction (see sample below). There was also an abstract lesson. Each context was composed of one lesson which contained 3 modules: central tendency & skewness, variability, and z-scores and the normal distribution. The treatments were identical in size, length, screen layout, and content sequence and complexity.

Method:

140 subjects were randomly assigned to 3 treatment groups: learner most preferred adaptive: subjects were administered the most preferred choice of context, learner least preferred adaptive: subjects were administered the least preferred choice of context, and non-adaptive or abstract group: subjects were administered the abstract lesson (no context). Subjects in all three groups were asked to select their most preferred context based on "the desirability of the domains as contexts for statistics lessons". Then they were asked to rate the remaining domains on a scale of 1 to 5 from most interesting to least interesting. There was a brief explanation of each context to facilitate the selection and rating process. An attitude/motivation survey was administered prior to and after the treatments to assess any change in students' attitudes/motivation towards statistics. The survey was an adaptation of two highly reliable attitudinal surveys: Keller's IMMS (Instructional Materials Motivation Survey) which had reliability estimates of 0.96 using a Cronbach alpha measure, and Roberts (Roberts & Bilderback, 1980) SAS (Statistics Attitude Survey) which had reliability estimates of 0.90 using the Spearman-Brown formula. The questions selected from both surveys were aimed at measuring students attitudes towards statistics and the perceived relevance of statistics to students' interests and experiences. Included in the pre-treatment survey were demographic questions asking students about their background (major, profession, age, and number of prior statistics courses), and general questions assessing students' degree of familiarity with the statistical concepts to be taught in the instructional modules. An abstract, or no-context achievement posttest, testing recall, application, synthesis, and evaluation of the statistical concepts learned in the CBI lessons was administered at the end of all 3 treatments.

Results:

14 students dropped the course prior to conducting the study. 12 students did not participate in the study. 114 students completed the pre-attitude survey. 81 students out of the 114 completed all parts of the study. The 28% attrition

rate was largely attributed to the fact that the instructor of the course had given the students the option of dropping one of their assignments for the semester and participation in the study was considered as one assignment. The researcher believes that the motive for participation became almost voluntary due to the criteria set by the instructor.

Out of the 81 complete records compiled from the study, only 28% selected their most preferred context in direct relationship to their major. This supports the principle that individual interest changes and that students' interests are not necessarily related to their academic major. In other descriptive statistical analysis, the study showed that 28% of the subjects (28 seems to be the magic number here) selected 'daily life' as their most preferred domain, followed by 24% for 'sociology', 14% science, 12% music, 11% fiction, 10% business, 1% education, and 0% selected 'the arts'.

No significant differences were reported on the dependent variable "relevance of statistics" and/or "attitude towards statistics" when using a single factor ANOVA with the independent factor being gain scores reported from the pre-post attitudinal survey. Further analysis is required to test whether there were any specific changes on selected components of the attitudinal scale such as professional relevance, personal relevance, educational relevance or general confidence in one's abilities towards the subject matter. The Cronbach alpha measure on the attitude instrument was 0.920.

The p-value reported on the dependent variable achievement, was 0.10 using a 95% confidence interval with the means being: 12.17 for the abstract (control) or no-context group, 11.42 for the least preferred adaptive and 10.19 for the most preferred adaptive. The variance for each of the levels was: 13.01 for the abstract (control) group, 15.37 for the least-preferred adaptive group, and 8.29 for the most-preferred adaptive group. Further analysis on the posttest items showed a p-value of 0.05 on application questions, and a p-value of 0.09 on the synthesis and evaluation questions combined. No significance was reported on the recall questions. The estimated reliability measure on the achievement posttest was 0.672 using a KR20 index. The overall posttest mean was 11.26% and the distribution of the test scores was clearly normal. A correlation of 0.40 was reported between the pretest measure of 'the degree of familiarity or knowledge of basic statistical concepts' and the achievement posttest scores.

Discussion:

The results of the pilot study suggest that it may be more useful to look at interactions rather than main effects. The variations obtained on the different learning outcomes on the achievement scores (p-value of 0.05 on application measures, 0.09 on evaluation/synthesis measures and 0.6 on recall measures) indicate that the independent variable may have greater effects on interactions between groups and types of learning outcomes. The high within group variance suggest that individual differences in aptitude, prior knowledge, and learning styles may have played a major role in masking a significant main effect. The experimental population was truly heterogeneous. In the Ross et. al studies (Ross et. al, 1986 #14) the groups were homogeneous in that the individuals in a particular treatment group had the same major and were at the same college level. A larger n is therefore required to detect significance in a heterogeneous population. Finally, a closer look at the CBI treatments revealed that they had minimal user interactivity. Emphasizing context as the primary instructional strategy, the treatments did not incorporate any other instructional strategy that promoted "mental effort" (Salomon, 1983a) defines the construct of "mental effort" as "the number of non-automatic elaborations applied to a unit of material", p. 42) and engagement. The treatments could best be described as "contextualized tutorials" or page turners.

Based on the above findings, the following design improvements will be implemented in the actual dissertation study:

- due to the extremely high variance of the three groups, a larger sample of subjects (at least twice the size of the pilot sample) will be used to be able to detect better significance;
- to justify that attrition is consistent and congruent among the three treatment groups, random assignment of subjects will be done at the time of CBI instruction by randomizing the treatments instead of the subjects;
- to improve the internal validity of the study, the subjects will be selected from an introductory statistics class (Statistics 200), and the CBI will be given as an independent study module that will count as homework credit;
- two contexts will be eliminated due to their low ratings: 'the arts', and 'education';
- the remaining contexts (sociology, science, daily life, business, music, and fiction) will be carefully examined in terms of their personal, social, and environmental implications and will be restructured to form distinctly relevant and non-relevant contexts for the experimental population;
- the achievement posttest will include questions from each of the context areas to find out whether subjects will do better on test items that match their lesson context;

- to enhance mental effort and task engagement, an inquisitory dialogue will be used when presenting the stimulus (instead of the story-telling approach that seemed to be prevalent in the pilot study treatments), and practice questions with corrective feedback will also be incorporated;
- since significance was better approached when analyzing the scores on the posttest based on subscales of learning outcomes, the posttest questions will be better delineated to be able to measure three distinct learning outcomes: recall, application, and inference.

Implications on Teaching and Learning:

Many schools are faced with the problem of delivering consistent, high quality, low cost introductory courses. An entire course (including lectures, text, computer guided instruction, item pool for exam-generation and a handbook for teaching assistants) which could be administered at relatively low cost, should prove highly marketable.

To maximize the efficiency of information transfer and to encourage students to view service courses as an added skill rather than a drudgery, the instructional design strategy of "adapting instruction to students' most personally relevant context" described above can be implemented to deliver a high quality course to an increasingly heterogeneous mix of students.

Other instructional variables such as structural features of the content, lesson sequencing and pacing, and type of feedback can also be manipulated using this adaptive strategy to support a more student-centered approach. The researcher maintains though that contextualizing content of quantitative subject matter remains the primary variable in promoting meaningful learning. Further investigation of this instructional strategy through an enhanced study is currently underway.

Sample of Contextualized Instruction

Introductory screen of a statistical lesson contextualized to the music domain:

You are working for the WKRZ radio station, and your mission is to do a market analysis to find out what type of music should WKRZ play, and at what time of the day, in order to attract the largest share of college students. You want to be able to tell potential advertisers that WKRZ has a high volume of young listeners as a target population. You conduct a survey on a random sample of college students and you include questions such as:

1. What type of music do you listen to? (classic rock, rock, new wave, etc.)
2. What time of day do you mostly listen to the radio and to what station?
3. How many hours per week do you listen to music in general?
4. What proportion of weekly hours do you spend listening to the radio?
5. How much money do you spend per semester on CD's? tapes?

Introductory screen of the same content contextualized to the business domain:

You are working for an investment company (Wall Street One) and your mission is to do a market analysis to find out what type of investment packages should Wall Street One set up, in order to target middle income families in the area. You want to be able to compete with already existing and established investment packages by offering a leading edge that is specific to your target population. You conduct a survey on a random sample of middle income families in the area and you include questions such as:

1. How much money do you spend on investments such as stocks, bonds, IRA accounts, etc., per week?
2. How many hours per month do you spend managing your investments?
3. How much money do you spend per week paying off credit cards and loans?
4. What time of day do you mostly talk to your investment agent or brokerage firm concerning questions and developments of your investment accounts?

Introductory screen of the abstract or no context lesson:

You have conducted a survey on a random sample of a target population and you want to describe the data resulting from the survey using some basic statistical measures that are typical of the values in the data set.

You cannot possibly list all the values you collected because there are too many. So you want to make sure that your analysis is indicative of the trends of the target population that you surveyed.

You asked many questions in your survey such as:
1. The number of hours they spend doing some activity per week.
2. The time of day they spend doing that activity.
3. The cost of doing the activity in dollars per week.
4. The proportion of time they spend on some activity verses other activities.

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Title:

The Effects of Learning Structures on Student Achievement and Attitude Using a Computer Simulation

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Abstract

The purpose of this study was to investigate the effects of using individual, cooperative, and collaborative learning structures with a computer simulation. College students implemented one of the three learning structures while using a computer simulation designed to teach the technical and procedural aspects of accounting. Results indicated that performance scores were high regardless of learning structure. However, students who worked alone expressed significantly more continuing motivation for their learning structure than students who worked with a partner. Responses to student interviews revealed somewhat mixed feelings for the small group structures. Furthermore, observation of the small groups indicated that students in the cooperative dyads exhibited significantly more discussion and provided more answers to their partners' questions than students in the collaborative dyads. Implications for implementing small group structures with computer-based instruction are provided.

Implementing Individual and Small Group Learning Structures with a Computer Simulation

There has been a great deal of interest recently in implementing small group learning structures in a variety of educational settings. The success of small group methods in classrooms (cf. Johnson & Johnson, 1989; Sharan, 1980; Slavin, 1990) has prompted educational technologists to examine the effect of employing small group strategies with computer-based instruction (CBI). According to Johnson, Johnson & Stanne (1985), small group structures reduce the social isolation inherent in the design of most CBI by providing students the opportunity to discuss what they are learning.

A number of research studies have been conducted to examine the effect of implementing small group methods with CBI. Some researchers have found that student achievement and attitude increases when small group strategies are used with CBI (Dalton, Hannafin, & Hooper, 1989; Hooper, Temiyakarn, & Williams, 1993; Johnson, Johnson, & Stanne, 1985; Schlecter, 1990). However, others have reported that individual and small group structures are equally effective when employed with computer instruction (Carrier & Sales, 1987; Orr & Davidson, 1993).

The mixed results for using small groups with CBI might be due to the type of small group method implemented in these studies. Two of the most frequently used small group methods are cooperative and collaborative learning. While both share similar elements, Smith and MacGregor (1992) have indicated that these methods can be placed into distinct categories of learning approaches that require joint intellectual effort. These categories are based on the structure required for each method.

Cooperative learning is the most highly structured of all small group methods (Smith & MacGregor, 1992) and has been defined as students working together on tasks that require interdependent goals and rewards (Smith, 1989). Cooperative learning activities are structured to include positive interdependence, face-to-face interaction, interpersonal and group skills, and individual accountability (Johnson & Johnson, 1988). Furthermore, group rewards are often provided to promote cooperation among students (Slavin, 1991).

Small group methods such as peer collaboration require less structure than cooperative learning (Davidson, 1985, Smith & MacGregor, 1992). Damon and Phelps (1989) have indicated that the two elements of equality and mutuality distinguish collaboration from cooperation. Equality is achieved when students with similar abilities work to help each other learn. Mutuality is influenced by the structure of a task when groups are required to work together. Division of labor structures, found in many cooperative settings, are low in mutuality since each student can work alone without exchanging information. Peer collaboration establishes a more mutual status than cooperative learning (Damon & Phelps, 1989).

The purpose of the current study was to investigate the effects of implementing cooperative, collaborative, and individual learning structures with a computer simulation in accounting. The Accounting Education Change Commission has recommended the addition of several instructional methods to accounting curricula, including active student participation, small group work, and the creative use of technology (ACC; 1990). The accounting simulation used in this study was designed for an ACC grant awarded to the School of Accountancy in 1991. The course designers and faculty wanted to determine if small group learning structures recommended by the ACC. (1990) were as effective as the individual learning structure originally implemented with the computer simulation.

There is very little research on using small group learning methods or computer-based technology in accounting education. A recent study by Ravenscroft, Buckless, McCombs, & Zuckerman (1993) indicated that college students in an introductory accounting course who worked in teams achieved higher grades than students who worked individually. However, no differences were found for students enrolled in a course on auditing. Furthermore, Oglesbee, Bitner, and Wright (1988) reported that students enrolled in an introductory accounting course who used CBI performed better than those in a lecture format. However, those results disappeared once the researchers controlled for prior achievement.

Method

Subjects

Subjects for the study were 105 college students (63 females, 42 males) enrolled in an accounting course at a large southwestern university. All subjects were completing prerequisite requirements for entry into an upper division, professional program in the College of Business. Students had completed a first semester course in introductory accounting with a grade of B or better. They were concurrently enrolled in a second semester introductory accounting course and in a computer laboratory course. The study was conducted in this computer lab.

Materials

The materials used in this study were a computer simulation designed to teach students the technical and procedural aspects of accounting and a set of student booklets designed to facilitate the implementation of the simulation in either an individual, cooperative or collaborative environment.

Computer simulation. The computer simulation, entitled An Introduction to Accounting: A Business Simulation (Birney & Smith, 1994), was designed using the framework of an accounting firm. All treatment groups used the computer simulation without any variations in the program. It provided pre-instruction, information, practice, and feedback on the topic of how to prepare adjusting journal entries.

In the simulation, each student was an employee of an accounting firm and reported to his or her office to begin each computer session. Once in the office, the employee's "desk" contained many tools such as a pop-up calculator, a FAX machine for messages from clients, computer E-mail for messages from the boss, and a calendar. The laboratory assignments were listed on the employee's calendar, which directed a student to the tasks to be performed and the order of completion for the tasks. Tasks that were completed showed a red check mark next to them.

The first part of the simulation was a tutorial session providing information and examples about how to prepare adjusting journal entries. Content and example screens were followed by 28 practice items which included fill in the blanks, numeric calculations, true or false statements, and constructed response (journal entry preparation and T-account analysis). The exercises required a student to use and apply various skills and knowledge in order to complete the next two parts of the simulation designated as practice sets.

Both practice sets were presented through a business simulation. At the beginning of each simulation, a pop-up calendar appeared on the screen, showing a list of the clients' books that needed to be adjusted (Queng Heating Co. and Holt Laundry). Both practice sets required a student to make decisions about the need for adjustments to the clients' books, to prepare accrual or deferral adjustments, to observe the posting of the adjustments, and to prepare an adjusted trial balance.

The format design of both practice sets included four steps. First, a memo from the client was shown on the screen listing various transactions that had occurred for the client's business. The instructions asked the student to select the transactions which would require adjustments. Next, the computer simulation displayed various internal and external documents pertaining to the transactions which the student reviewed in the memo. The instructions asked the student to prepare the necessary adjusting journal entry for each source document. The third step instructed the student to post the adjustments to the general ledger. The fourth step showed the student the various posted accounts from the general ledger and instructed them to prepare an adjusted trial balance.

A practice exam followed the second practice set. This exam included 21 items which were similar in content and design structure to the tutorial and simulation practice exercises. The practice exam was scored by the computer and constituted 10% of a student's grade. After the practice exam, the computer provided a review of questions that the student answered incorrectly. This review provided both the right answer and an explanation of why that answer was correct.

Student booklets. Three different student booklets were designed to provide directions and procedures to implement an individual, cooperative, or collaborative learning structure. The basic design for each booklet was a content and activity outline of the computer module for Preparing Adjusting Entries. In addition, different prompts were printed on the booklets to help students consistently utilize treatment-specific instructions.

The booklet for the individual treatment group included a set of instructions describing the procedures each student was to follow in the computer lab. It directed students to work individually on each part of the simulation. The booklet included generic prompts in the introduction such as "use the space provided in your booklet to note any questions you have about the material." It also supplied procedural prompts throughout the booklet such as "you are now ready to start working on Practice Set I."

The booklet for the cooperative treatment group included a set of instructions describing the procedures each student would follow in a cooperative dyad. The introduction explained that students would take turns performing the role of preparer and checker. The duties of each role were described in the introduction; students were informed that the preparer should "do the work at the keyboard" and the checker should "check the work and provide assistance as needed." The booklet included procedural prompts throughout to remind to frequently rotate their roles and to ensure that each member of the dyad would practice the skills and knowledge included in the simulation. The booklet also reminded students to shift the mouse and keyboard over to the preparer each time there was a switch in roles.

The booklet for the collaborative treatment group included a set of instructions describing the procedures each student would follow in a collaborative dyad. The introduction provided general directions such as "work by yourself at your own computer and make notes of questions you want to discuss with your partner." The booklets also included procedural prompts throughout which directed students to work alone during designated portions of the lesson, make notes of questions to ask their partner, and discuss these questions with their partner at specified times during simulation.

Procedures

This study was implemented over a two week period in a computer laboratory as part of required course activities. Prior to the study, students were informed that they would participate in a research study and that extra credit would be awarded to students who attended each of the four, 75 minute class sessions.

Several weeks before the study, seven intact classes were randomly assigned to either the individual, cooperative, or collaborative treatment conditions. Before assignment to treatments was made, test scores from the first course examination were collected and analyzed to established equality between the classes. A one-way analysis of variance of these scores revealed no significant difference between classes for prior achievement. The following section describes the procedures followed by subjects in each of the treatments.

Individual treatment. Students working individually followed the standard lab format for the class. On Day 1, each individual received a student booklet and were told to note where they stopped at the end of each lab session. Students then worked alone on the computer simulation. On Day 2, individuals received their booklets as they entered the lab and were instructed to proceed with the simulation. On Day 3, individuals were told that they should finish the simulation by the end of the day. Students completed the practice exam and review after practice set 2. On Day 4, students completed a pencil and paper posttest and then entered their answers on the computer. Immediately following the posttest, students completed an attitude survey. Twenty-eight students from the individual treatment participated in an interview about the study after they completed the posttest and attitude survey.

Cooperative treatment. Students in this treatment condition used a cooperative learning structure suggested by Kagan (1989). This strategy required two students to work together to complete the simulation, alternating the roles of preparer and checker. Positive interdependence was achieved through the structured tasks each partner had to perform, and by providing the mutual goal of reaching consensus on a solution. In addition, the pair received the same grade on the practice exam, which constituted 10% of their total unit grade.

On Day 1, students were randomly assigned to a dyad; each dyad was assigned to a computer. Students were informed that they would receive the same score for the practice exercises and practice exam. Each student was given a booklet and told to note where they stopped at the end of each lab session. Students then worked cooperatively on the computer simulation. On Day 2, each student received their booklet and were reminded to switch roles as prompted. On Day 3, dyads were again reminded to switch roles and were told that they should finish the simulation by the end of the day. Dyads completed the practice exam and review together after practice set 2. During the practice exam, students were preparers for half of the questions and checkers for half of the question. On Day 4, each student individually completed a pencil and paper posttest and then entered their answers on the computer. Immediately following the posttest, each student completed an attitude survey. Twenty-nine students from the cooperative treatment participated in an interview after they completed the posttest and attitude survey.

Collaborative treatment. Students in this treatment condition used a collaborative learning strategy while completing the simulation. Each dyad member individually worked through one part of the simulation at a time and were directed to note questions or concepts they wanted to discuss with their partner. Students were prompted at specified points in the lesson to consult with their partner to discuss these questions. Positive interdependence was achieved by structuring activities so that students would benefit from sharing their ideas and responding to other's questions and comments.

On Day 1, students were randomly assigned as dyads to computers that were adjacent to each other. Each student was given a booklet and told to note where they stopped at the end of each lab session. Students then worked collaboratively on the computer simulation. On Day 2, each student received their booklet and were reminded to individually complete part of each practice set and then consult using the notes they made in the booklet. On Day 3, students were again reminded to use the collaborative method and were told that they should finish the simulation by the end of the day. Students individually completed the practice exam and review after practice set 2, and then collaborated with their partner on notes they made during the practice exam. Each student received an individual grade on the practice exam. On Day 4, each student individually completed a pencil and paper posttest and then entered their answers on the computer. Immediately following the posttest, each student completed an attitude survey. Thirty students from the collaborative treatment participated in an interview about the study.

Criterion Measures

Criterion measures for this study were student achievement, attitude, time on task, student interactions, and responses to student interviews.

Achievement was measured using a 35 item, paper and pencil posttest designed to assess student mastery of the skills taught in the computer simulation. The test items were of a similar nature to the tutorial and practice set items and asked for knowledge answers, numeric calculations, true or false choices, and constructed responses. There were 21 selected response items and 14 constructed response items on the posttest. The KR-21 reliability of this test was .75.

Attitude was measured using an eight item, paper and pencil survey. Students used a five point, likert-type scale (1 = strongly agree, 5 = strongly disagree) to record their responses to the following items:

1. The unit was interesting.
2. I learned a lot from this unit.
3. I did well on the posttest.

4. I like working alone/with a partner.
5. I learn more working alone/with a partner.
6. I would take other courses structured like this one.
7. The grading for this unit was fair.
8. I am very comfortable using computers.

The attitude survey was administered immediately after the posttest. The Cronbach alpha reliability of this survey was .76.

Time on task was tracked by the computer simulation which captured the amount of time students spent on the tutorial, both practice sets, and the review.

The number of student interactions exhibited by dyads in the cooperative and collaborative learning structures were observed and recorded on an observation sheet. This observation sheet included interaction behaviors that other researchers have suggested as necessary for successful group work (Klein & Pridemore, 1994; Webb, 1982, 1987). These interaction behaviors were grouped into five categories of questioning (asking a question), answering (answering a question), encouraging (giving praise or unsolicited help), discussing (talking about content or task), and off-task (verbal and non verbal behaviors). Trained observers were stationed among four dyads to observe each dyad and record observations at approximately two minute intervals during the first, second, and third lab periods. The observers watched each dyad for five minute intervals during the fourth lab period. During a pilot study, three observers watched the same dyad for several two minute intervals and recorded their behaviors. Reliability was based on all three observers having similar totals for this dyad. The inter-rater reliability between observers was .85.

Student interviews were conducted using a five question, written interview protocol. Questions about the computer lesson and learning structures were based on student responses obtained from interviews conducted in the pilot study. Students volunteered to participate in these one-to-one interviews. They were conducted by one interviewer after each student completed the posttest and attitude survey. Approximately 84% of the students who participated in the study (87 out of 105) volunteered to be interviewed.

Design and Data Analysis

This study used a posttest only, control group design with the one independent variable of learning structure (individual, cooperative and collaborative). The dependent variables included student achievement, attitudes, time on task, student interactions, and responses to interviews.

A one-way analysis of variance (ANOVA) was conducted on the posttest data. ANOVA was also conducted on data for overall time on task and time spent on each section of the simulation. Separate 3 (learning structure) X 5 (item selection) chi-square analyses were conducted for each item on the attitude survey. The number of interactions exhibited by students in the cooperative and collaborative treatments were totalled and categorized as questioning, answering, encouraging, discussing, and off-task. Separate chi-square analyses were conducted on each category of interaction behaviors. Finally, responses to student interviews were summarized and reported as percentages.

Results

Student Achievement

The mean posttest achievement score was 31.30 for students in the individual learning structure, 31.19 for students in the collaborative learning structure, and 30.94 for students in the cooperative learning structure. Student performance across all groups was 31.14 or 89%. ANOVA indicated that the difference between the treatment groups on the posttest was not statistically significant.

Student Attitudes

Student responses to the attitude items revealed that most students thought that the unit was interesting (76 out of 105; M = 2.12) and believed that they learned a lot from it (86 out of 105; M = 1.98). In addition, most students thought that they did well on the posttest (71 out of 105, M = 2.13), that the grading for the unit was fair (88 out of 105, M = 1.97), and that they were very comfortable using computers (85 out of 105, M = 1.86).

Separate 3 (learning structure) X 5 (item choice) chi-square analyses were conducted for each item on the attitude survey. These analyses indicated a significant difference between the learning structures on one of the eight attitude items. Chi-square indicated a significant difference for the item "I would take other courses that were structured the same as this one," $X^2 = (8, N = 105) = 14.49$, $p < .05$. Data revealed that 70% of the students in the individual learning structure agreed or strongly agreed with this item, compared to only 36% of the students in the cooperative structure and 22% in the collaborative structure. In contrast, only 12% of the students in the individual learning structure disagreed or strongly disagreed with this item, compared to 42% of the students in the cooperative structure and 28% of the students in the collaborative structure.

Time on Task

Time data revealed that the average number of minutes spent on the entire simulation was 140.18 for students who worked alone, 145.44 for students who worked cooperatively, and 144.15 for students who worked collaboratively. ANOVA indicated that the differences between these means was not statistically significant.

In addition to overall time spent on the simulation, data were collected for the amount of time students spent on the tutorial, both practice sets, and the review. These data indicated a significant difference between treatments for the review portion of the simulation, $F(2,102) = 3.40$, $p < .05$. The average number of minutes spent on review was 5.31 for students who worked alone, 11.35 for students who worked cooperatively and 7.25 for students who worked collaboratively. Post hoc analysis using Tukey HSD pairwise comparisons revealed that students who worked cooperatively spent significantly more time on review than students who worked alone, ($p < .05$).

Student Interactions

Table 1 summarizes the number of student interactions exhibited by dyads in the cooperative and collaborative learning structures. These interaction behaviors were grouped into five categories of questioning, answering, encouraging, discussing, and off-task behaviors. Chi-square analyses were performed on each of the five different behaviors to determine the influence of learning structure. These analyses indicated a significant difference between cooperative and collaborative learning structures on two of the five behaviors. Students in cooperative dyads exhibited a total of 459 discussion behaviors while those in the collaborative dyads exhibited 218 discussion behaviors, $X^2 = (1, N = 36) = 12.29$, $p < .001$. Students in cooperative dyads also provided significantly more responses to their partners' questions (194) than students in the collaborative dyads (136), $X^2 = (1, N = 36) = 10.19$, $p < .01$.

Responses to Student Interviews

Table 2 provides a summary of student responses to the five interview questions. These data suggest that the majority of students responded that the simulated practice sets were the most helpful feature of the computer lesson. Seventy-nine percent of individual subjects, 48% of cooperative subjects, and 57% of collaborative subjects listed the practice as the most helpful aspect of the lesson.

Participants were also asked what aspects of the student booklets were helpful. Thirty-six percent of individual subjects, 55% of cooperative subjects, and 43% of collaborative subjects listed the organization and instructions as most the most helpful feature of the booklets. However, 57% of individual subjects, 45% of cooperative subjects, and 43% of collaborative subjects indicated that they did not use the booklets throughout the entire lesson.

Responses to questions about learning structure revealed that 57% of individual subjects, 52% of cooperative subjects, and 43% of collaborative subjects indicated a preference for working alone over working with a partner. Finally, 71% of individual subjects, 62% of cooperative subjects, and 60% of collaborative subjects responded that working with a partner would be more enjoyable than working alone. However, only 46% of individual subjects, 38% of cooperative subjects, and 40% of collaborative subjects said they would learn more working with a partner.

Discussion

The purpose of the current study was to investigate the effects of using cooperative, collaborative, and individual learning structures with a computer simulation. College students enrolled in an accounting course implemented one of the three learning structures while using a computer simulation to learn how to prepare adjusting entries to close clients' books.

Results indicated that scores on the performance test were high regardless of learning structure. The average achievement score was 89% for subjects in all three treatments. This result is likely due to the students who participated in the study. Prior to this study, all subjects had completed an introductory accounting course with a grade of B or better; most indicated that they would pursue a college major in accounting. Furthermore, scores from a test given prior to the study suggested that subjects had a high degree of ability to perform tasks similar to those taught in the computer simulation. It is likely that these students would perform well regardless of their placement in an individual or small group learning structure.

This explanation is consistent with results found by other researchers. Ravenscroft et al.(1993) found that small group learning increased scores of students in an introductory accounting course, but did not influence performance in an advanced course on auditing. Oglesbee, Bitner, and Wright (1988) reported that prior achievement had a strong influence on scores in an accounting course regardless of the medium used to deliver instruction.

Results for time on task indicated that students spent the same amount of overall time working on the simulation regardless of learning structure. In addition, no differences were found for time spent on the tutorial and on both practice sets. However, cooperative subjects did spend significantly more time on the review portion of the lesson than subjects in the other learning structures. One possible explanation for this finding is that students in the cooperative learning structure felt that the benefits of review would increase because of additional discussion and elaboration of the content.

The result that small group subjects did not spend more time than individual subjects on the simulation is not consistent with other cooperative learning studies. In fact, Slavin (1990) indicated, "most studies that have measured time on task have found higher proportion of engaged time for cooperative learning students than for control students" (p.47).

Observations of students in the individual learning structure may shed some light on why these students spent as much time on the simulation as those in the small group structures. These observations suggested that individuals frequently accessed the on-line reference book, which was bright red in color and noticeably visible on screens throughout the laboratory. This likely increased time on task for individuals.

While results suggested that the three learning structures were equally effective, findings from the attitude survey revealed that students who worked alone expressed significantly more continuing motivation for their learning structure than students who used the small group structures. Approximately 70% of students in the individual condition reported that they would take other courses structured like this one, compared to 36% of students in the cooperative condition and 22% in the collaborative condition.

Furthermore, responses to the interviews revealed somewhat mixed feelings for the small group structures implemented in this study. Results showed that 57% of individual subjects, 52% of cooperative subjects, and 43% of collaborative subjects indicated a preference for working alone rather than with a partner. While more than 60% of students in all three conditions reported that they would enjoy working with a partner, less than half of subjects in all conditions said they would learn more working with a partner. This is consistent with other researchers who found that some students like working in small groups even when their achievement does not increase (Palinscar & Brown, 1979).

The results of the current study may be explained by the elaborations provided by students during the interviews. Many of the subjects from the cooperative and collaborative treatments qualified their responses about small group structures with the conditions that 1) their partner should be a student who had a similar commitment level to school, 2) the subject should require thought and analysis rather than memorization, and 3) the class format should include in-class activities and instructor assistance on team formation and skills. They thought such a course must have "hard stuff, not self-explanatory stuff or stuff you just memorize" and that a "lab class isn't good (for small group structures) unless the computers are networked and you change the software."

Results from the interviews also suggest that approximately 44% of subjects in both small group structures did not consistently use the workbooks which were designed to prompt them to cooperate or collaborate. Observation of students in the small groups provided evidence that subjects used the workbook during Day 1 of the study, but tended to ignore the workbook on subsequent days. Students who elaborated their answer to the interview questions provided further evidence that the workbooks were not implemented as intended. Many students remarked that they only used the workbook to keep track of where they got to each day.

Even though they did not use the workbooks as directed, students in the small group conditions did exhibit interaction behaviors during the lesson. Using the workbooks during Day 1 of the lesson may have been enough to prompt these interactions. Prior experience in small group learning in the introductory accounting course also may have contributed to the occurrence of these interaction behaviors.

The results for student interaction were consistent with the design of the cooperative and collaborative learning structures. Students in the cooperative dyads exhibited significantly more discussion about the content and tasks than students in the collaborative dyads. Students in the cooperative structure also provided answers to their partners' questions significantly more often than those in the collaborative structure.

These differences can be attributed to the nature of the two small group structures under investigation. In the cooperative structure, students were told to assume specific roles of preparer and checker and to switch these roles frequently. Cooperative subjects also used one computer throughout the lesson. In keeping with Davidson's (1985) suggestions for how to design collaborative learning, the collaborative dyads were provided with less structure than the cooperative dyads. Students in the collaborative dyads each used their own computer and were directed "not to discuss as you go" but rather to wait and consult with their partner about their questions at specific points in the lesson.

Observations of each dyad for five minute intervals on the last day of the study confirmed that students in the cooperative and collaborative conditions exhibited different patterns of interactions. Many students in the cooperative learning structure talked aloud while working through the simulation, asked questions, and waited for agreement from their partner. Most exchanges of information went back and forth many times, as opposed to one sided comments. Many students in the cooperative dyads looked at each other when they spoke.

In contrast, students in the collaborative learning structure seemed to develop a non verbal signal of staring at their partner's screen when they needed to consult. Little eye contact or face to face conversations occurred. Most collaborative students spoke to their own computer screens when asking questions or giving answers. Comments were usually brief, one sided events.

The current study provides some implications for educational technologists who design and implement computer-based instruction. Results indicate that small group structures do not always increase student learning and motivation, especially for high functioning students. When computer resources permit each student to work at a computer, the investment of additional time to create small group learning structures may not be justified. In cases where learning objectives specifically include the mastery of group and social skills, the investment of time necessary to redesign the computer instruction for group use may be warranted. This study suggests that adjunct materials such as workbooks are not the best method of prompting students to work together when using computer instruction.

Since computer resources are often limited, educators are forced to group several students at one computer. Future research should be conducted to determine the most effective ways to enhance learning when students work in small groups at the computer. A recent study by Sherman & Klein (in press) indicates that embedded prompts can influence student interactions and achievement when cooperative learning is combined with computer instruction. Future research could explore embedded prompts in computer simulations. Research should also continue to examine different types of learning structures when students use computer technologies. Finally, future research should continue to explore the use of computer simulations in college classrooms to determine the most effective structures for implementing this technology into the curriculum. Such research can assist educational technologists in constructing the best combination of learning structure and tasks so that the learning experience is enhanced.

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Table 1

Number of Student Interactions for Cooperative and Collaborative Dyads

Type of Interaction	Learning Structure Cooperative	 Collaborative
Questioning	181	157
Answering	194	136
Encouraging	61	49
Discussing	459	218
Off task	21	21

Table 2

Summary of Student Responses to Interview Questions

What features of this computer lesson helped you learn?

	Ind	Coop	Coll
Simulated practice sets	79%	48%	57%
Working with a partner	0%	24%	40%
Booklets	18%	0%	0%
Everything	3%	28%	3%

What features of the student booklet did you find helpful?

	Ind	Coop	Coll
Didn't use booklet	57%	45%	43%
Organization/instructions	36%	55%	43%
All of it	7%	0%	14%

Do you prefer to work alone or with a partner to learn?

	Ind	Coop	Coll
Alone	57%	52%	43%
Partner	43%	38%	40%
Either is OK	0%	10%	17%

Do you think you would have learned more if you had worked alone or with a partner?

	Ind	Coop	Coll
Alone	43%	21%	27%
Partner	46%	38%	40%
Same with either	11%	38%	33%
Depends on subject	0%	3%	0%

Do you think you would have enjoyed this module more if you had worked alone or with a partner?

	Ind	Coop	Coll
Alone	29%	31%	37%
Partner	71%	62%	60%
Same with either	0%	7%	3%

Title:

Instructional Design Fundamentals as Elements of Teacher Planning Routines: Perspectives and Practices from Two Studies

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Overview

A careful review of the teacher planning literature illustrates clearly that teachers rely on mental planning to guide what occurs in their classrooms . This mental planning, or reflective mental dialog, not only precedes written planning, but occurs throughout the design, implementation, and evaluation phases of instruction. It is a key element in planning *prior* to teaching, in reflection, monitoring, and adjustment *during* teaching, and in reflective evaluation and revision *following* teaching.

This presentation builds upon the findings (often mixed) of prior research , and, based upon the results of ongoing studies of the practices of elementary school teachers, focuses on the teacher use of ID skills in the planning and delivery of instruction. In particular it takes a close look at the relative and "real" use of ID practices in both mental and written planning.

Background

Two decades ago, Beilby's (1974) efforts to narrow the gap between teacher educators and instructional technologists focused on our need as a field to "relinquish a considerable portion of [our] ID role to teachers" (p. 12). His charge was based on our common mission "to facilitate and improve the quality of human learning" (Ely *et al*, 1972). Although this clarion call was repeated by Stolovitch (1980), very little change occurred until the decade of criticism spawned by *A Nation at Risk* (1983).

In the more inviting context of school reform, instructional designers began to display increasing interest in sharing their skills with classroom teachers. The proposed interventions covered the whole gamut of the educational process — from teacher preparation (Burkman, 1987; Earle, 1985, 1992; Klein, 1991; Martin & Clemente, 1990; Reiser & Mory, 1991; Reiser & Radford, 1990; Snelbecker, 1987) to teacher inservice (Shrock & Byrd, 1987; Schiffman, 1987) to systems redesign (Banathy, 1991; Branson, 1987; Reigeluth, 1987; Reigeluth & Garfinkle, 1992; Reiser & Salisbury, 1991; Salisbury, 1993). However, the approach to reconciliation was often one-sided, more along the lines of "what we can offer you," rather than a search for common ground — an approach which re-emphasized the fact that these two professional groups have remained separate and aloof in both research literature and instructional theories.

Although it might be reasonable to assume that researchers and theorists from two closely related fields such as teacher education and instructional design would work collaboratively to exchange ideas and concerns about the improvement of instruction, the gap between both fields has instead widened over the years. Until recently, instructional design and teacher education were viewed as separate fields. Despite an amazingly common interest (i.e., the teaching and learning process), teacher educators and instructional designers read and write separate literature and study different theoretical procedures .

Hence ID interventions for the classroom are perceived by teachers and teacher educators as low in credibility— largely because there exists little common language or understanding for communication. If we are to successfully continue our venture into school reform, then we need to understand what's happening in schools and in teacher education.

All of us who wish to contribute to schools would be well advised to read what school people read and go where school people go.This means stretching beyond our typical spheres of communication to try to understand schooling from the perspective of those who "live" there (Shrock, 1990, p. 29).

While many teacher educators view instructional design skills as important, few teacher education programs offer courses that would provide opportunities for students to develop instructional design skills. Since it is unlikely that the public schools will employ many instructional designers, and it *is* likely that teachers in public schools will pay more attention to design principles, teacher education programs are challenged to develop strategies to bridge the gap between the theory of instructional design and the practice of teaching.

Recent efforts by several instructional designers, in providing focused observations on what teachers do in their classrooms and how we can best mesh our expertise with theirs, have generated the following insights:

- systems approach principles can be taught to preservice teachers
- differences exist between Id models and teacher models of thinking and learning
- teachers implicitly apply ID practices when planning to teach
- teachers think and talk about instructional planning in different ways

Reiser (1994) reflected upon three years of research into the use of ID skills in teacher planning, sharing his overall impressions as well as suggestions for future research. He indicated that systems approach principles can be taught to preservice teachers quite successfully but that additional instruction and skill applications were necessary to ensure effective and continued use of ID skills by teachers. Moallem (1994) explored an expert teacher's model of thinking and teaching within the context of the social context of the classroom. This ethnographic study, which compared teacher thinking to instructional design, suggested fundamental differences between these two models. Kennedy (1994), in order to determine whether teachers use ID or personal heuristics, reviewed four Canadian studies of ID knowledge, competency, and use. She concluded that teachers have an abysmal understanding of learning theory as an underlying framework for instruction. She felt that their inability to see instruction from a systems perspective was ample evidence of the need for ID skills in preservice training.

Branch (1994) introduced his study of secondary teachers with a discussion of the constituent elements of an instructional episode and the fundamental components of ID. In particular, he stressed the need to translate ID jargon into teacher language, and indicated that teachers implicitly apply ID practices when planning to teach. Driscoll, Klein, and Sherman (1994) examined how teachers and instructional designers think and talk about instructional planning. They explored the differences which exist in how both groups conceive of their practices in order to determine how such differences contribute to the lack of perceived impact of ID in teaching contexts. Garbosky (1994) took a "then and now" approach by comparing (after six years) the activities, experience, and feelings of educators formally trained in instructional design. Her article illustrated quite well the reality and the breadth of the gap between the two fields.

There is no question that teachers design instruction, even if they do not follow classical ID principles, and even if they don't consider what they do to be instructional design (Clark & Angert, 1980). Zahorik (1975) classified teacher decisions in the design process into eight categories: objectives, content, activities, materials, diagnosis, evaluation, instruction, and organization. Note the similarities between these categories of design decisions and the common elements of ID models compiled by Andrews and Goodson (1980). In addition to these categories, the teacher planning literature has attended to the time frames of planning and the products or processes of planning (McCutcheon, 1980; Clark & Yinger, 1979; Morine-Dershimer, 1978-9; Peterson, Marx, & Clark, 1978; Zahorik, 1975). More recent research has emphasized the practical application of ID skills in the planning processes of teachers (Earle 1992; Reiser & Mory, 1991; Klein, 1991; Martin, 1990; Martin & Clemente, 1990). Research on teacher planning emphasizes its importance as process (Arnold, 1988; Yinger 1977) and indicates that teachers make decisions "about lesson plans, interactive teaching, modifications required during teaching, and other ways... to routinely plan and evaluate and modify instruction" (Snelbecker, 1987, p. 35).

Bridging the Gap: Two Studies

Do teachers typically employ instructional design practices when they are planning their instruction? If so, what practices do they employ? If not, why don't they employ them? Are the planning practices of those pre-service and in-service teachers who have been taught basic instructional design principles different from the practices ot those who have not been taught these principles?

The first study involved twenty-two elementary teachers from schools across North Carolina (NC) The second study included seventeen elementary teacher from Provo School District in Utah (UT). Both groups responded to a detailed survey which covered demographics, general information, and practices in yearly, unit, and daily planning. Similar questions addressed each level of planning. Follow-up interviews which delved further into planning issues were held with teachers selected from each group.

Patterns of Practice

The results of both studies with elementary school teachers indicate the following trends or patterns in their planning and delivery practices:

- Teachers favored mental planningwhile recognizing the importance of written planning, particularly at the unit level. Production of written plans was closely related to administrative requirements.
- Plans tended to be more specific at the unit and daily levels in all areas (content, materials, activities, objectives, and tests) and more general at the yearly level (see Table 11).
- Most teachers who have had formal training in instructional design felt that a knowledge of ID had improved their planning processes (NC 81% ; UT 90%).
- Most teachers consciously used ID processes in their planning (NC 60% ; UT 73%).
- The crucial elements of the ID process were goals, learner analysis, objectives, activities and strategies, tests, and revision (see Table 4). These aspects were also considered formally (see Table 1) and were more likely to be included in written plans (see Table 2). Note the mixed results with learner analysis. Task analysis, types of learning, instructional plans, and try-out were considered helpful but tended to be addressed informally and mentally.
- ID processes received more attention at the unit and daily levels of planning rather than at the yearly level (see Table 3).
- Most teachers gave equal importance to written and mental planning (see Table 5).
- During teaching, there was less deviation from unit and daily plans (both of which were considered more important) than from yearly plans (see Tables 6 and 7).
- Initial planning decisions centered around content and objectives at all levels (see Table 10) while most planning time focused on content, materials, and activities (see Table 9).
- Trying out the instruction prior to using it in the classroom was impractical for elementary teachers. They relied on mental imagery and planning to test the instruction prior to delivery. Afterwards, reflection allowed for revision.

Moving Ahead[1]

Instructional designers offer teachers a vast array of expertise in the improvement of instruction and learning. However, since teachers and technologists often view both teaching and technology differently, emphasis must be placed on closing the gap, on developing productive ways of working togerher. "In order to make any real headway as a field, we will have to come to some reconciliation of our differences if we want our diffusion efforts in teacher education to pay off" (Martin, 1990, p. 56).

However the pay-off will depend on our performance. In an analysis of the techniques of Coach "Bear" Bryant in building a winning team at the University of Alabama, Gilbert and Bilbert (1988) report:

> Two -thirds of all fourth grade kids who sign up voluntarily to learn to play woodwind instruments quit within 60 days. The reason? No indication of any likelihood of success... when it comes to motivation, phony displays of warmth are no substitute for evidence of successful performance (p. 34).

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[1] These ideas were first expressed in Earle, R.S. (1994). Instructional design and the classroom teacher: Looking back and moving ahead. *Educational Technology*, 34 (3), 6-10.

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May I suggest, then, that as we move ahead to where we, as instructional designers, should be in our relationship with classroom teachers and the public schools we base our performance on the following guidelines derived from looking back at where we've been.

- Develop a common technical language of instruction based on an integration of the literature from both fields.
- Validate the scientific bases of teaching as essential precursors of the art of teaching.
- Adopt a layers-of-necessity philosophy in modifying classical ID to meet the needs and practices of teachers.
- Recognize the need for piece-meal reform and fundamental systemic restructuring as concurrent, interactive ventures.

An examination of the mental planning processes of teachers necessarily brings us face to face with the multifaceted, dynamic, complex nature of the teaching. Though the process is often perplexing, we have an opportunity to savor the adventure of taking a look into the world of the classroom teacher. As we strive to blend the research and theories of teacher education and instructional design, perhaps a deeper recognition of the richness of teacher planning practices will provide avenues for the modified implementation of ID strategies and techniques to enhance the quality of human learning.

Table 1: Formal and Informal Use of ID Processes (%)

	Formal		Informal	
	NC	UT	NC	UT
Develop or review course and unit *goals*	43	*63*	48	*50*
Develop a *task analysis* or learning hierarchy to identify prerequisite skills and sequence of instruction	24	*25*	67	*68*
Classify *types of learning* indicated in the content	14	*12*	76	*88*
Analyze the abilities and need of *learners*	71	*25*	24	*88*
Develop performance or behavioral *objectives*	62	*50*	38	*56*
Develop *tests* that match the learnings described in the objectives	62	*69*	33	*38*
Select or produce learning *activities and strategies* that match the type of learning and objective	76	*69*	29	*31*
Follow a systematic *instructional plan* (e.g., Gagne's events of instruction or Madeline Hunter's steps, etc.)	62	*31*	43	*63*
Try out the instruction prior to using it in the classroom	14	*0*	71	*81*
Revise the instruction based on the results observed during teaching	52	*56*	57	*69*

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Table 2: Written or Mental Plans (%)

	Written		Mental	
	NC	UT	NC	UT
Goals	62	*88*	62	*63*
Task Analysis	29	*63*	76	*69*
Types of Learning	14	*6*	90	*88*
Learner Analysis	43	*31*	86	*88*
Objectives	86	*75*	33	*38*
Tests	86	*81*	52	*50*
Activities & Strategies	86	*63*	52	*56*
Instructional Plan	52	*69*	62	*81*
Try Out	19	*0*	86	*81*
Revise	76	*50*	71	*81*

Table 3: Use of ID Processes in Yearly, Unit, and Daily Planning (%)

	Year		Unit		Day	
	NC	UT	NC	UT	NC	UT
Goals	50	*63*	70	*81*	30	*25*
Task Analysis	30	*38*	45	*69*	25	*38*
Types of Learning	10	*25*	25	*63*	35	*31*
Learner Analysis	30	*44*	50	*50*	65	*75*
Objectives	40	*38*	45	*81*	45	*63*
Tests	10	*13*	55	*88*	35	*50*
Activities & Strategies	20	*13*	55	*88*	70	*69*
Instructional Plan	10	*13*	35	*56*	70	*69*
Try Out	10	*6*	20	*19*	25	*44*
Revise	30	*6*	55	*69*	75	*81*

Table 4: The Value of ID Processes (%)

	Year		Unit		Day	
	NC	UT	NC	UT	NC	UT
Goals	67	*88*	33	*12*	0	*0*
Task Analysis	25	*25*	67	*75*	8	*0*
Types of Learning	17	*12*	50	*88*	33	*0*
Learner Analysis	92	*88*	8	*12*	0	*0*
Objectives	83	*5*	0	*25*	17	*0*
Tests	75	*69*	17	*31*	8	*0*
Activities & Strategies	83	*69*	17	*31*	0	*0*
Instructional Plan	17	*19*	75	*69*	8	*12*
Try Out	0	*0*	75	*75*	25	*25*
Revise	67	*63*	33	*37*	0	*0*

Table 5: Importance of Written and Mental Plans (%)

	Written		Mental		Equal	
	NC	UT	NC	UT	NC	UT
Overall	25	*6*	37.5	*19*	37.5	*75*
Year	31	*53*	31	*7*	38	*40*
Unit	29	*19*	7	*12*	64	*69*
Daily	33	*0*	27	*31*	40	*69*

Table 6: Following Plans (%)

	Year		Unit		Daily	
	NC	UT	NC	UT	NC	UT
Very Closely	8	*7*	8	*6*	13	*20*
Closely (< 25% deviation)	46	*33*	77	*69*	67	*67*
Somewhat Closely (25-49% deviation)	31	*60*	15	*25*	20	*7*
Somewhat Loosely (50-75% deviation)	15	*0*	0	*0*	0	*6*
Very Loosely (> 75% deviation)	0	*0*	0	*0*	0	*0*

Table 7: Importance of Planning (%)

	Year		Unit		Daily	
	NC	UT	NC	UT	NC	UT
Crucial (100% of the time)	23	*20*	31	*38*	60	*33*
Useful (75% of the time)	46	*60*	69	*62*	40	*67*
Generally Useful (50% of the time)	31	*13*	0	*0*	0	*0*
Minimally Useful (25% of the time)	0	*7*	0	*0*	0	*0*
Not Very Useful (<10% of the time)	0	*0*	0	*0*	0	*0*

Table 8: Amount of Written Planning (%)

	Overall		Yearly		Unit		Daily	
	NC	UT	NC	UT	NC	UT	NC	UT
More than 75%	29	*19*	33	*44*	33	*19*	27	*19*
50%-74%	18	*31*	20	*12*	33	*44*	20	*12*
25%-49%	35	*25*	27	*19*	27	*25*	33	*50*
Less than 25%	18	*25*	20	*25*	7	*12*	20	*19*

Table 9: Percentages of Planning Time (Mean %)

	Yearly		Unit		Daily	
	NC	UT	NC	UT	NC	UT
Content	26	*32*	22	*21*	18	*23*
Materials	17	*20*	19	*22*	24	*28*
Activities	23	*20*	27	*27*	28	*25*
Objectives	24	*17*	20	*15*	20	*13*
Tests	7	*9*	10	*12*	9	*10*

Table 10: First Decisions (%)

	Yearly		Unit		Daily	
	NC	UT	NC	UT	NC	UT
Content	43	*64*	29	*71*	14	*29*
Materials	5	*0*	5	*0*	5	*7*
Activities	5	*0*	0	*0*	14	*14*
Objectives	48	*36*	62	*29*	67	*50*
Tests	0	*0*	0	*0*	5	*0*

Table 11: Specificity of Plans (%): NC

	Very Specific			Somewhat Specific			Somewhat General			Very General		
	Y	U	D	Y	U	D	Y	U	D	Y	U	D
Content	30	44	37	15	44	47	35	11	11	20	0	0
Materials	20	44	32	25	39	47	30	11	16	20	6	5
Activities	15	33	37	15	56	42	45	17	21	20	0	0
Objectives	40	61	47	40	33	47	10	6	0	10	0	11
Tests	10	22	32	20	39	32	10	17	0	35	17	20

Table 12: Specificity of Plans (%): UT

	Very Specific			Somewhat Specific			Somewhat General			Very General		
	Y	U	D	Y	U	D	Y	U	D	Y	U	D
Content	20	50	38	27	38	56	40	12	6	13	0	0
Materials	20	38	56	40	62	38	33	0	6	7	0	0
Activities	13	31	38	47	63	56	20	6	6	20	0	0
Objectives	53	69	60	20	25	27	7	6	13	20	0	0
Tests	27	38	53	20	56	33	33	6	13	20	0	0

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Title:

Internet-Distributed College Courses: Instructional Design Issues

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Abstract

College courses have now gone beyond the walls of the traditional college classroom into cyberspace. These new Internet course offerings bring about major instructional design issues that must be acknowledged and addressed during the course development phase. Two of the major issues are Internet access requirements and clarity of instruction. However, there are also other educational issues that must be considered such as incidental learning, quality control, and cultural climate.

Internet-Distributed College Courses: Instructional Design Issues

Moving the campus to the cyberspace horizons has forced course designers to rethink their instructional strategies and delivery methods. We no longer think of single classrooms, but interlinked students both on campus and globally. Choices need to be made as to the target audience and whether or not it will be a university-wide virtual offering or a cyberspace, international virtual offering. As we enroll diverse students from a variety of nations, our instructional strategies have to break the mold associated with traditional, on-site, classroom-contained teaching methods (Shuell, 1993). As a result, ease of access to the Internet and clarity of instruction have become two paramount issues that must be dealt with at the onset of the course development process. Other educational issues also surface during course construction and delivery.

Internet Access

Internet access was one of the initial, major concerns that faced the authors. Although through the university's system, access capabilities typically included e-mail, gophers, telnet, and the World Wide Web, not everyone who enrolled in the courses would necessarily have access to the university's system or to all the levels of the Internet. Thus, an examination was done as to the capabilities on different systems.

For the most part, it was determined that individuals who would enroll in the Internet-distributed college courses would have accounts on a university system, a commercial Internet provider, a local school district system, or a local freenet system. Levels of Internet access varied with each of those systems. With university systems and commercial Internet providers, access to the Internet seemed to be the most complete. Next in line was a freenet system; however, some freenet systems did not have telnet or Web capabilities. Internet access via local school district systems seemed to be the most limiting, since many systems allowed for only e-mail access.

After the Internet access analysis was completed, the next thing that the authors did was decide on the Internet-related activities that they wanted the students to perform. In cases where the course consisted of information distribution and communication between peers and instructor, basic e-mail access was all that was needed. However, in the courses that required the enrollees to search the Internet for course-related information and material, e-mail only Internet access became a major obstacle. To prevent problems caused by people enrolling in courses and then later finding out that their Internet access was not sufficient to complete the Internet course, the decision was made to include requisite Internet access capabilities as part of the course description.

Clarity of Instruction

Instructor Presence

Clarity of instruction was the second key factor that caused concern for the authors. Professor and student "presence", in the traditional sense, was virtually eliminated with the Internet distributed courses. Thus, the professor had to clearly define the course content, while identifying all possible interpretations of what was actually included in the context of the information sent to the students. In an attempt to replace the professor-initiated, in-class reinforcement, learning objectives had to be correlated and specifically communicated to the students for each course topic covered and assignment given (Shuell, 1996). This was done to alleviate any misunderstanding and to show an interconnection between the course objectives, the topics covered, the assignments, and the use of the Internet. As a result, course preparation time and effort increased because of the expanded clarification demands.

Levels of Interactivity

Not only did the course information have to be clear and concise, the level of interactivity and quantity of communication were associate issues. It was important to consider the amount of interpersonal exchange necessary to meet the course objectives (Shuell, 1993). Each course had its own level of interactivity. There were four levels of interpersonal exchange that entered into the design process: instructor-student, student-student, instructor-guest expert, student-guest expert. A decision had to be made as to the synchronous versus asynchronous communication that needed to occur at each interpersonal exchange level. To enhance professor-student intercourse, electronic office hours were established to create an atmosphere somewhat resembling the traditional office time required of professors teaching on-campus.

Course Enrollment

Course enrollment was yet another factor that influenced the communication exchange expected to take place during a virtual course. For courses that have a large enrollment (e.g., over 50 course enrollees), the quantity of synchronous communication has to be either severely limited or eliminated. Even for courses where the number of enrollees is fewer than 50, guidelines need to be formulated before the start of the course in an effort to keep the communication flowing, but manageable (Shuell, 1996).

Other Educational Issues

There were, and are, many educational issues associated with Internet-distributed coursework. Decreased incidental learning from cyberspace isolation must be considered not only in the development process but by the potential student. Quality control issues arise when there are no cyberspace proctors to validate a course enrollee's identification; do you know that the student who is receiving the grade did the work? There are cultural climate issues both in the development and implementation of the course related to instructor and student input, terminology, interpretation, and overall professional conduct. As university faculty and administrators become more experienced in offering virtual courses, the easier it will be to research educational issues and formulate solutions to the virtual problems that arise. Unfortunately, we are still struggling with these major educational issues, but that does not preclude their consideration and identification since those issues can impact the overall integrity of the Internet-distributed course.

Conclusion

As with all teaching, Internet-distributed courses need to be constantly evaluated and revised to continually improve the product and maintain the quality reputation of the professor and the offering institution. Conquering this new frontier is difficult and will remain challenging, but in today's society, universities who do not venture into this vast electronic world face the possibility of losing students to virtual competitors.

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Title:

Classic Writings On Instructional Technology

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Most books are stimulated by events or needs experienced by individuals. The preparation of *Classic Works on Instructional Technology* was no different. The editors participated in the design of an educational technology curriculum at the University of Twente in The Netherlands in the early 1980s. In an attempt to describe the content of a new curriculum, a review of the literature was necessary. Questions about the "core" literature, "seminal" works and the "roots" of the field led to a search that continues today.

About the same time, one of the editors was teaching a course on Perspectives of Educational Technology, a graduate seminar that attempted to communicate the "geography" of the field--the conceptual contributions of the people, the events, the legislation, the ideas, and the movements that have helped to shape the profession. Logical resources for such an endeavor are the publications of the field--the written history of the profession. The next step is to ask: "What publications are the 'classics' of the field--those books and articles that have withstood the test of time and are still read and quoted?" Mark Twain described a classic as "something everyone wants to have read and nobody wants to read." What would happen if you were to create a list of classics?

Even when a reasonably satisfactory list is created, how does one locate the articles themselves, many of which have disappeared over the years? Sometimes a colleague has squirreled away a copy in a personal archive or a library still has the paper copy or a micofiche. Wouldn't it be helpful if all these classic works could be brought together in one volume? At least it would save searching for articles that are now obscure. If might also help to document the history of the field through its literature. This book is an attempt to make such important articles readily available. It also attempts to provide a partial conceptual history of the *primary* works that often are side-stepped for more recent interpretations of the older gems. When historians do history, they go back to the original sources, not secondary interpretations and digests. The editors have attempted to collect the original articles that are difficult to find. They are the original works--the primary writings upon which many of today's ideas are based.

The Selection Process

What initially seems like a fairly routine task becomes a nightmare because each educational technology professional has his/her own ideas about which articles are "classics". The process began with one editor preparing a list based on his own experience and the frequency of citations in major works such as the histories of Reiser (1988) and Saettler (1990) and encyclopedia articles of Eraut (1985) and Clark and Solomon (1986). When the second editor joined the team, there was agreement on more than half of the original titles and suggestions for alternative and additional titles. The list was still too long and there was some disagreement about some of the titles. Clearly, a broader perspective was needed. A list of 35 tentative titles was sent to 40 individuals who were members of the Professors of Instructional Development and Technology (PIDT) group in the United States and several leaders in European countries who teach courses in which the publication might be used.

Respondants were asked to nominate other titles that should be considered for inclusion the the collection. More than 30 individuals reacted to the original list of titles. There was a high level of agreement on about half the titles and suggestions for 36 more works, a half dozen of which were mentioned more than once. Several new perceptions and ideas that would influence selection emerged from the comments of the respondants:

* There are books that ought to be considered classics. The authors felt that a representative article or a chapter from a book could be included in the collection. For example, Gagne's *Conditions of Learning*, (1965) uses a surrogate article, "Learning Heirarchies (Gagne, 1968) " that communicates the conceptual essense of his books.
* North American educational technologists are much less familiar with articles published in Europe; for example, Davies (1978). The authors felt that their combined experience in North America and Europe was sufficiently valid to make judgements about selecting European articles even though they were relatively unknown in North America.
* Despite descriptions and instructions about the classics and the criteria for expressing opinions, many respondants wanted articles that were more "up-to-date". Many felt that there were more recent publications that better represented contemporary thinking. For example, several respondants recommended using the new Association for Education Communications and Technology definition (Seels and Richey, 1994) rather than the 1977 AECT definition. Of course contemporary thinking is better represented by the 1994 publication than the 1977 work but it is difficult to call a recent publication a classic! The authors had to veto the suggestions for more contemporary listings because they would violate the basic premise that the articles are "...first to introduce the concept;" and "...often quoted as a primary reference..." as indicated in the list of criteria.

* The number of new titles introduced by the respondants caused some reflection by the authors. Clearly, all of them could not be added but some initial titles could be dropped in favor of suggestions that seemed to make more sense. Several changes were made as a result of this input.

A further check on the utility of the proposed articles was their use in a graduate seminar held just before the final selection was made. Students read and reacted to a wide spectrum of articles, many of which were on the original list. They expressed their opinions regarding the value to them as they were about to enter the profession. Their opinions added useful input and a "reality check" since they represented the ultimate users for whom the book is intended.

The table of contents sent to the publisher ultimately contained 30 articles of various lengths. The publisher's review of the text when adjusted to a uniform typographical format indicated twice the number of pages that had been estimated. At this point, retention of items was based on several criteria: (1) difficulty of access; (2) older items; (3) "core" of the literature; and (4) published in the United States (since the primary users would be in North America). This wrenching task left 17 of the 30 articles.

The conclusion, based on the experience of the selection process, is that each educational technologist has his/her own list of "classic" articles from the professional literature. This idiosyncratic opinion is based on such factors as the university in which graduate study was done, courses taught by the individual and the satisfaction received from a specific publication at one time or another during one's professional career. The final decision as to what to include is a mix of the authors' personal "favorites," the "votes" of professional colleagues and the input of students who will be the readers of this volume.

Organization of the Book

There is no one conceptual organization of educational technology that is acceptable to all professionals. It seems that each person views the field from a personal perspective based on the individual's experience with those aspects of the field that fall within the scope of one's daily work. When it comes to organizing the "classic" works, one scheme would appear to be almost as logical as the next. The authors have chosen to use the following approach:

1. Definition and Conceptual Background
    1.2 The field and its definition
    1.2 Theory and rationale
2. Design and Development Functions
    2.1 Design and development
    2.2 Evaluation
3. Delivery Options
    3.1 Media
    3.2 Methods and techniques
4. The Profession

The table of contents is appended to this paper.

A Final Comment

It is apparent that these are "dated" articles. Most of them come from the three decades following the end of WorldWar II. Each article is representative of the author's contributions to the field of educational technology. There are ten times the number of articles contained in this volume that constitute the core literature of the field. Some are within the range of dates used here; many more are published later. The contents of this book are "classics" as noted by many practitioners in the field. There probably would not be 100% agreement among all the individuals who participated in the nomination process. In the book readers will find an expanded bibliography of many works that have helped to establish the field as a profession.

Donald P. Ely

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CLASSIC WRITINGS ON INSTRUCTIONAL TECHNOLOGY

Donald P. Ely and Tjeerd Plomp

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Title:

Students' Responses to Case-Based Instruction: The Role of Perceived Value

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Abstract

Although much of the pedagogical literature suggests otherwise, not all students find case-based instruction interesting and valuable or are confident learning from this method. In this exploratory study, we examined how students responded to case-based instruction by exploring similarities and differences among nine students' experiences in a case-based biochemistry course. Nine first-year veterinary students were interviewed three times during the semester to explore their initial and changing responses to case-based instruction. Two general patterns of responses emerged during our analysis. These patterns revolve around the value that students assigned to case-based instruction and describe the extent to which they felt motivationally challenged or frustrated by the case method. Implications for the development and use of case studies in professional education programs are discussed.

Although case-based instruction has been accepted as an effective teaching method in business and law schools for over a century, very little work has been done which carefully examines how individual learners respond to case-based instruction (Knirk, 1991). The general implication in the literature is that students find cases motivating (e.g., Shulman, 1992), yet a few educators have argued that case-based instruction might not "work" for all learners (e.g., Cossom, 1991). Given the fervor with which case-based instruction is currently being advocated in professional education (Shulman, 1992), it is important to understand how this instructional method affects the persons most directly involved in it. What are students' perceptions of case-based instruction? How interesting and valuable do students find this method; how confident do they feel learning from this approach? What makes this type of learning more or less challenging than other instructional methods?

In general, case-based instruction is a teaching method that requires students to actively participate in real or hypothetical problem situations reflecting the kinds of experiences naturally encountered in the discipline under study. Although there are many varieties in both form and style, case-based instruction tends to support a focus on professional education as a process, not a product. As such, it is believed to develop practitioners who can make sense of problems that are not always straightforward or clear-cut.

It is not unusual for those who advocate the use of case-based instruction to assume that students will be motivated to deepen their understanding when confronted with authentic problems in realistic situations (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, and Palincsar, 1991). Unfortunately, not all students are adequately prepared to direct their own learning in a case-based environment. Cossom (1991) stated that, "Clearly (case-based instruction) is not a teaching/learning method that appeals to all students nor is it one that draws neutral responses" (p. 151). Providing students with opportunities to integrate their knowledge through case studies may not be effective if they lack the skills or motivation needed to regulate their learning. It is important for case instructors to be aware of students' responses to the case method and to provide support for those who are unprepared, intimidated, or reluctant to engage in these unfamiliar learning tasks.

This study departs from traditional summative/evaluative or media/method comparison studies in that it describes case-based instruction from the participants' point of view and describes those aspects that learners found most valuable and/or frustrating about the case method. By examining a variety of students' responses we hoped to identify instructional conditions, learner characteristics, and/or learning strategies that facilitated or limited students' responses to this method. Ultimately our goal was to provide educators with information about how to design/utilize the approach so that benefits of case-based instruction might be maximized for all learners expected to learn from it. Thus, the questions guiding data collection were

(1) How do students respond to case-based instruction? Which aspects do they find interesting, valuable, and worthwhile? Which aspects are difficult or frustrating?

(2) How do students' responses change as they gain experience with the case method? What happens to their interest, value, and confidence for learning from this method during a semester long course? What happens to frustration?

Methods

This study used qualitative methodology to explore the perspectives of a diverse group of veterinary students who were recently introduced to case-based instruction. Semi-structured interviews, conducted with nine first-year students, constituted the primary data source and were supported by additional data gathered from classroom observations, students' written case analyses, informal teacher interviews, and student course evaluations. Qualitative analysis methods were used to search interview data for patterns of responses to case-based instruction. Comparisons were then made across time to assess changes in students' responses over the semester.

The Site

A professional school of veterinary medicine, located at a large midwestern university, is one of only 27, nationwide, that grants the degree of Doctor of Veterinary Medicine (DVM). This particular school follows the traditional model of veterinary education, which according to Turnwald, Bull, and Seeler (1993), "is based on the concept that the primary purpose of education is transmittal of knowledge and skills" (p. 38). Didactic instruction is provided in the areas of anatomy, pathobiology, physiology, and pharmacology, and tends to rely on "fact-laden lectures, assigned readings, drills, quizzes, rote memorization, and examinations" (p. 38). Laboratory experiences are included in the first three years, yet are primarily directed toward transmitting information to the students. In their fourth year, students assume responsibilities of "junior practitioners" in actual clinical and lab settings.

The 4-year program typically limits enrollment to 60 students per class. According to the school catalog, "each prospective student is required to complete a prescribed preprofessional curriculum for two or more collegiate years before admission to the school." Academic performance (e.g., overall GPA, required courses GPA, overall academic performance, and GRE score) accounts for 50% of the admissions criteria, and non-academic activities (interview, work experience, extracurricular activities, veterinary and non-veterinary animal experience, application and essay quality, and references) constitute the other 50%. Due to the equal weight assigned to academic and non-academic criteria, the student population is perceived to be fairly heterogeneous.

The Course

A required freshman course, Systemic Physiology II (Biochemistry), provided the context for this study. The course is described in the syllabus as "an introduction to biomedical principles and their application to veterinary medicine." The lab portion of the course focused on the application of principles learned in lecture to hypothetical patients who mimicked real-life disorders. At the time of the study the same instructor taught two sections of the lab. Although students were assigned to one lab, they typically attended the one that was most convenient during any specific week. Therefore, the number of students in each lab section fluctuated between 15 and 45 students.

Systemic Physiology II was designed so that students received approximately 2 hours of both lab and lecture each week throughout the 16-week semester, yet grades were weighted such that lab performance accounted for only 27% of the total course grade (a common practice in lecture-lab courses reflecting the perceived "density" of their respective information loads). Biochemical case studies were used as the primary instructional method and as an evaluation tool in both lab sections of the course. Grades assigned in lecture were based on 3 objective-type exams; lab grades were based on a term paper, a group case presentation, and an individual case analysis. The case analyses completed during lab meetings were not graded but were designed to give students practice applying biochemistry principles to realistic problems typically encountered in professional practice.

Case study presentations followed a fairly typical pattern. Students were presented with a limited description of an animal in distress. Some of the animal's symptoms were described, accompanied by appropriate illustrations and diagrams, and then students were asked to analyze the patient's condition and to make tentative diagnoses and recommendations for action. As an example, one of the cases is included here:

> **Signalment**: A German Shepherd dog, castrated male, 7 years of age.
> **History**: This dog has been a family pet since he was 6 weeks of age. He received a proper series of "puppy shots" and has been vaccinated every year for rabies and DHLPP (Distemper, Hepatitis, Leptospirosis, Parainfluenza, and Parvovirus). He receives heartworm prevention through the spring, summer and fall of each year, and has tested negative for heartworm disease each year. Normally very active, he has been lethargic for the last 7 to 10 days. He doesn't want to run and play like he used to, and he sleeps a lot more. His appetite is decreased a little, and he threw up once last week. The family has noticed that he coughs in the morning when he gets up and coughs after a nap.
> **Physical**: Weight is 87 pounds, slightly overweight. Heart rate is 190, temperature is 101.4, and respiration is 20. Appears bright, alert, and responsive and is calm. Mucous membranes are more pale than normal, teeth have some tartar, and there is early gingivitis. Ears, eyes, and throat are normal. A lipoma (diagnosed last year) is present over the left thoracic wall. Thoracic auscultation reveals harsh lung sounds, and a grade 3 of 6 murmur is noted in the fifth intercostal space on the left side. Abdominal palpation is normal. Musculoskeletal system is normal except for a slight degree of muscle wasting in the rear legs. Nervous system appears normal.
> **Lab results**: See the Complete Blood Count, Chemistry Profile, and Urinalysis.

Following a standard veterinary analysis procedure called "SOAP," students analyzed each case by indicating their subjective (S) and objective (O) evaluations of the animal, their assessment (A) of the animal's condition, and their recommended plan (P) for action. This analysis procedure had been introduced during the previous semester but received increased emphasis in the biochemistry lab. Students used this procedure to complete their case analyses throughout the semester yet were encouraged to streamline the process as the semester continued so that it required less time. Students typically worked in groups to complete their SOAPs and were encouraged to ask questions, to check available resources, and to consult with the instructor before making preliminary diagnoses.

All case investigations concluded with a large group discussion in which student recommendations were considered in light of the available lab and clinical data. A final diagnosis was determined after a number of likely diagnoses were identified and rank-ordered from most to least probable. A discussion of the biochemical mechanism(s) of the disease, as well as the effect of recommended treatments on the biochemistry of the disorder, served to link case specifics to basic biochemical principles. Although the teacher indicated why the selected diagnosis was most probable, she continually stressed the need to leave many possibilities open, even those not initially considered to be very likely.

Participants

Students. Sixty-one first-year veterinary students were enrolled in the biochemistry lab during the study. Sixty-six percent of these students were female (n = 38), and ages ranged from 20 to 40 years (M = 24.22, SD = 3.99). Although the majority of students (n = 36) had completed a bachelor's degree, levels of education ranged from two years of post-secondary education (n = 15) to a master's degree. Most students had backgrounds in either biological science or agriculture.

In order to capture a wide range of responses to case-based instruction, interview participants were purposively chosen to represent different ages and genders, and to include a range of educational and work-related experiences. The final interview sample included 7 female and 2 male students ranging in age from 21 - 32 years; in years of related veterinary experience from 0 - 13; in number of previous related courses from 0 - 3; and with GPAs from 2.6 - 4.0. Table 1 presents specific demographic information for the nine interviewees, arranged alphabetically by participants' pseudonyms.

Table 1.

Demographic Information for Interview Participants

Student	Gender	Age	Yrs of school (post HS)	# of previous biochemistry courses	GPA	Related experience
Chrissy	F	22	4	1	3.53	BS-Eng/Chem double major
Deena	F	22	4	2	2.71	BS-Animal Bioscience; Pre-Vet
George	M	21	2	0	2.60	Pre-Vet; swine, cattle experience
Mallory	F	23	4	3	3.61	Pre-Vet; worked in Animal Control
Marci	F	22	3	1	4.00	BS-Biology; worked 4 yrs in small animal clinic
Ronald	M	23	4	0	3.06	BS-Biology; raises snakes
Roslyn	F	32	4	1	2.80	13 yrs in vet clinic; 3.5 yrs in small animal ICU
Sharon	F	24	4	2	2.94	BS-Animal Science; 5 yrs with small animal vet; 2 yrs equine emergency referral service
Winnie	F	26	5	0	2.52	BS-Biology; dressage instructor

The teacher. At the time of the study, Eileen Morrison (a pseudonym) was a 34-year-old practicing veterinarian, as well as a graduate student in the School of Education. Besides working half-time at a small animal clinic, Eileen also had an assistantship that required her to teach the biochemistry lab. Of the other eight core teachers in the freshman curriculum, six were DVMs and held advanced degrees (PhDs) in their sciences; two had advanced degrees only. Of these eight core teachers, two had private practice experience.

Eileen had been teaching this particular lab for two years, gradually increasing her use of case studies until they had become the primary instructional method. According to previous course evaluations, students liked the case approach, typically rating the lab as a 9.0 on a 10-point scale. In addition, students indicated that they liked Eileen as a teacher, with average semester ratings between 9.3 - 9.5. Unsolicited comments from students indicated that they liked her relaxed teaching style, personable manner, and sense of humor. The fact that Eileen was a practicing veterinarian seemed to increase both her credibility and approachability. Eileen's perception was that students trusted her to present practical and relevant information; students saw her knowledge as being rooted in practice.

Procedures

Three times during the semester, all 61 students were asked to complete individual written case analyses. After each of these cases, semi-structured interviews were conducted with the 9 selected students to explore their responses to the case method. The first set of interviews was conducted during the third week of the semester. Second and third interviews occurred approximately midway through the semester (week 8) and again at the end of the semester (week 15). Specifically, interviews included questions related to students' perceptions of their interest/enjoyment ("How interesting is this instruction to you?"; "How do you like this type of instruction?"), value ("How valuable is this approach to you?"), and efficacy ("How confident are you learning from this method?").

These 27 interviews constituted our primary data source and were supported by secondary sources in the form of students' written case analyses, classroom observations, teacher case documents, informal teacher interviews, and course evaluations. The use of multiple data sources and methods allowed us to triangulate analysis efforts, thus reducing potential subjectivity. In addition, member checks were secured from the teacher and interviewees throughout the research process.

Data Analysis

To answer our research question of how students responded to case-based instruction, our data analysis began with a search for patterns of responses within each participant's responses (within-case) and then across all learners (cross-case) using a constant comparative method (Glaser & Strauss, 1967). By examining within- and cross-case fluctuations over the semester, we were able to describe students' changing responses.

Thus, the analysis process began with a search for students' positive and negative comments across all interviews and progressed to identifying similarities and differences among comments. For example, as we first began to transcribe interviews, we noted instances where students expressed enjoyment or frustration related to the case method in general or to the specific case they had analyzed. We highlighted the reasons students gave regarding feelings of frustration or enjoyment and constructed tentative matrices that outlined similarities, as well as differences, among students' responses. As we analyzed subsequent interview comments we continued to modify our original matrices—deleting, adjusting, or adding categories of responses to reflect emerging themes.

The example below illustrates our analysis approach. In the first interview, students were asked, "How do you feel about using cases?" We present Ronald's response along with the first author's tentative codings (in parentheses) about the meaning of his response. Ronald's reasons for valuing (or devaluing) the case approach are underlined.

> I enjoy doing them (positive; task value?). They do cause frustration (negative) because right now I really don't know what I'm doing. I don't have a lot of background (external factors; task difficulty; saving face?). I enjoy doing it (positive); it's a change of pace. Right now there's stress (negative) but hopefully that will change with the years (positive) as I become more comfortable with them (not confident now, but expects to improve) and get a wider background. But now they're causing stress (negative) because there's, well, I have no idea what it could possibly be—I only know 2 diseases and that's all (excuses? self-protection?).

Based on this small interview excerpt, we identified a number of possible themes: value due to enjoyment and change of pace; frustration due to a lack of knowledge and an uncertainty of what one was supposed to be doing; poor performance due to task difficulty and lack of background experience; expectation that ability and confidence would improve.

After completing this level of coding for Ronald's comments, we completed similar codings for the other eight students interviewed. By looking at each student's response to this question, we saw similar, as well as additional or opposing themes. By continuing to look for similarities and differences across students' responses, we gradually clarified and refined our codes to reflect salient themes across individuals, while still noting contrasting features and contextual circumstances surrounding positive and negative responses.

As themes continued to evolve, we began attending to changes in students' responses during the semester. Whereas some students became more frustrated over time, others became more interested and more motivated. By paying close attention to the conditions under which students' responses changed, we noted different patterns of responses among students who remained motivated and those who became frustrated. For example, students began to express more confidence as their focus changed from learning facts to learning the case approach (product vs. process goals). On the other hand, students voiced more frustration as they encountered more difficult cases, as outside pressures mounted, or as the novelty wore off. These critical changes in responses helped us identify conditions related to students' facilitative or limiting responses, taking us past isolated themes and categories to the relationships among them.

Results

In this study we asked questions about how students responded, initially and over time, to case-based instruction. Two general patterns of responses emerged during our analysis and interpretation of the data collected in this study. These patterns revolve around the value that students assigned to case-based instruction and describe the extent to which they felt either challenged or frustrated by the case method. As suggested by motivational research (e.g., Malone & Lepper, 1987), feeling challenged is thought to be a facilitative response whereas feeling frustrated is considered a limiting response. Figure 1 illustrates our conception of how levels of perceived value related to students' responses to case learning in this study. Perceived value, as defined here, includes students' levels of interest in the use of cases in the biochemistry lab course, the perceived relevance of the case method to their current coursework and future career goals, and levels of confidence for both successful performance and ability to learn from this method. Prior to presenting a description of the two general response patterns, we use excerpts from students' interviews to illustrate how each component of perceived value (interest, relevance, and confidence) shaped students' responses to this case-based course in facilitative or limiting ways.

Levels of Perceived Value

<———Low———— ————Interest/Relevance/Confidence——————————High———>

limiting facilitative

Students' Responses

Feeling frustrated **Feeling challenged**

Figure 1. Relationship between levels of perceived value and students' responses to case-based instruction.

Component One—Initial and Changing Interest in Case-Based Instruction

Initial interest. In describing their initial reactions to the use of cases in the biochemistry lab, eight of the nine interviewed students indicated that they thought that cases would make the class more interesting and more fun. In the first interview Winnie explained, "Of course you are more interested in the case because it relates to medicine and to what you want to do later in life. Biochemistry, or physiology, or anatomy is very dry and it's not alive. But working with diseases—it kind of gets you more interested." Mallory indicated, "Biochemistry lab is the most interesting course that we have."

Four students likened cases to a game or puzzle and mentioned the challenging, enjoyable aspects of cases. Mallory stated, "It's more of a challenge; it's like playing a game to see if you can win. It's fun." Six students described how their motivation had increased and one student, Marci, even mentioned how cases had affected her efforts outside of class: "It motivates me to do a lot of extra reading because a lot of stuff you don't get just by going to classes." For the most part, students indicated that case-based instruction was more interesting than their other classes and provided a nice change of pace. Mallory contrasted case-based instruction with her other courses, "I like them (cases). I mean it's not boring. It's not 'memorize these facts and spit them back to me.'" Only Deena qualified her comments stating, "They're good, but only to a certain degree."

Changing interest. By the end of the course, Chrissy, Deena, and Ronald mentioned that casework was becoming tedious and that their motivation had decreased due to other pressures. Chrissy stated, "Sometimes it got to be a really long afternoon when we're going over the same things." Even though these students were "burned out" by the end of the semester, most of their frustration seemed related to outside sources (e.g., other tests, deadlines), rather than to the course. Ronald explained, "Right now things are swamped, end of the year. I'm just burned out I guess." Course evaluations support the conclusion that most students still enjoyed the course at the end of the semester. On a scale from 1-10 the average course rating was 8.9. Unsolicited student comments on the evaluation form included enjoying the case-study approach and having fun in class: "Truly enjoyed labs; they made my others relevant." "I greatly enjoyed lab!!! It was the only class in our curriculum which makes you think logically about cases you will see as a clinician."

Component Two—Initial and Changing Relevance for Case-Based Instruction

Initial relevance. All nine students claimed that cases were "real-life" and had some practical benefits. Chrissy, Deena, and Ronald noted that cases would help them remember more, yet still judged that this would probably not affect other coursework or career goals. Chrissy stated, "I'm planning to be a non-practicing veterinarian so I can't really predict what role, if any, these cases will have." Deena explained, "It's going to help me learn things better, but I don't think I'm going to be remembering these cases when I'm working in the real world." This contrasts with five other students who stated that the case method was very valuable to their future careers, as well as to other coursework. Marci stated, "Cases will definitely help me out in the future. They will help me be a better veterinarian." Not only did these students value the practicality of case-based instruction, but they also noted some global benefits such as learning the problem-solving approach and integrating their knowledge. Sharon stated, "I'm in the situation where I'm trying to pull together everything that I learned in biochemistry as an undergrad and things we're learning in physiology and anatomy and pull everything together through biochem lab. The case studies kind of integrate it and you see where everything connects."

Changing relevance. As the semester went on, there seemed to be a shift regarding which aspect of the case approach was valued most. Students who initially focused on practical benefits (change of pace, ability to remember more facts) began to mention more overarching benefits (application of knowledge, learning the problem-solving approach). The case analysis process, rather than the product, seemed to take on increased relevance. George stated, "I think the biggest thing to me is the whole process of thinking through the different diagnoses. It's just a whole mind set that we're getting into." Ronald mentioned how the case method helped him organize his thoughts and decided, as did Chrissy, that cases *could* help in applying knowledge learned in other courses.

Component Three—Initial and Changing Confidence for Case-Based Learning

Initial confidence. All of the students expressed some concern about their ability, at this point in their careers, to diagnose the cases they were given. Marci explained, "I was a little intimidated because I knew I didn't have a lot of knowledge to help me figure out what was going on." Chrissy stated, "Right now I'm not terribly confident in my performance." Students used words such as scared, frustrated, nervous, and intimidated. However, everyone but Deena indicated that this lack of knowledge would lead to greater effort. Marci said, "I probably put more effort into understanding what we learn in this class because I know it will definitely be useful."

Changing confidence. As students became more comfortable with the problem-solving approach, as their knowledge base increased, and as their experience with cases increased, they appeared more confident of their case analyses. However, students' confidence seemed primarily related to the amount of prior knowledge and previous experiences they had. Ronald indicated, "If I had a broader repertoire of possibilities, I would have felt more confident." Still, Roslyn and Marci mentioned being motivated by this lack of knowledge. Roslyn remarked, "It's like a kid with a new video game!"

As the semester continued, students seemed to redefine success and to adjust their judgments of confidence to match. They began to emphasize "coming close" rather than naming a specific disease. If diagnoses were "in the ballpark" students judged their work to be successful. Mallory said, "I knew this and this, but being able to list a specific problem, no, I don't know enough diseases to write anything down. But it comes close."

By Time 3, scared and nervous feelings were no longer mentioned, yet Chrissy, Deena, and Ronald expressed frustration due to a lack of knowledge, the specific case, or tediousness of the work. These students were more apt to complain about other responsibilities, other course requirements, and external factors (time and length of lab) that contributed to their stress. Deena explained, "I got frustrated because when I have so many other things to be doing, I don't want to do it." Marci, Sharon, and Winnie also expressed concern about a lack of knowledge, yet tended not to dwell on this. Rather, they reminded themselves of the overall value of casework. Winnie stated, "Although it's frustrating if I get every one of them 'wrong,' I think this is the way to learn." Sharon and Marci both indicated, "We'll be better clinicians because of it."

Summary

Students in this course were observed to respond differently to case-based instruction based on their perceived value for the case method, including their interest in the use of cases, the perceived relevance of cases to their current and future work, as well as their perceived confidence for learning from this approach. Furthermore, these responses appeared to vary as interest, relevance, and confidence levels changed. Although all of the students interviewed in this study found the case method interesting and valuable at the start of the semester, value "levels" were not equivalent across students. Whereas some students simply stated that cases were enjoyable and a nice change of pace, others described important connections to their other coursework or career goals, as well as to their overall motivation and confidence for learning.

As indicated earlier, students' perceived value changed during the semester, both by level and by type. That is to say, some students changed in terms of the amount of value they assigned to case learning (with some assigning more, others assigning less) as the semester progressed; some changed their reasons for valuing the method, for example from a focus on the enjoyment aspects to one on perceived relevance to future career goals. These varying levels and types of perceived value appeared pervasive in influencing students' initial and subsequent responses to case-based instruction. For example, students who initially placed high value on the integrative and linking functions of cases (e.g., Marci, Sharon, Winnie) appeared to maintain a high value for the case method throughout the semester. Students who changed their emphases from practical and immediate benefits to more long-term benefits (e.g., George, Mallory, Roslyn) appeared to increase in perceived value for the case method. Still, a few students (e.g., Chrissy, Deena, Ronald) who initially valued cases because they were interesting and "not too hard," decreased in perceived value as the novelty wore off and cases became more difficult.

In general, students who valued the case method as a useful learning tool tended to emphasize learning the case analysis process and directed their efforts toward mastering the analysis approach. These students seemed to prefer tasks which were new, challenging, or difficult so "they could learn from them." Students who did not perceive the relevance of the method to their current or future work, and/or who lost interest in the method seemed more interested in learning specific biochemical facts and did not seem to enjoy the challenge provided by new and/or difficult cases. Wigfield (1994) suggested that when learners are engaged in tasks for utilitarian purposes (e.g., to complete a task, to get a grade) they may not wish to be as challenged as those who hold high value for the task. If a task is too challenging, such learners may begin to look for other tasks that could meet their utilitarian needs in less challenging ways.

In summary, students who described case-based instruction as being relevant to their current and future work, who expressed high interest in and enjoyment of the case teaching method, and who were confident that they could learn relevant skills and information in this manner, appeared *motivationally challenged* by the case method. In contrast, students who expressed concern that they might not learn all the biochemical facts they needed to know, who were not convinced of the relevance of these cases to their other work, and who were unsure of their ability to perform successfully, felt *frustrated* by this approach.

Discussion

The results of this exploratory study point to the potential role that perceived value (as defined by levels of interest, relevance, and confidence) may play in shaping students' responses in a case-based course. Although our results must be regarded as tentative, given the small number of participants, they suggest important areas for future research. Perceived value, as a motivational component of learning, has been described in the literature as influencing one's willingness to learn. Wigfield (1994) suggested that learners' "valuing of different tasks may be an important precursor of their willingness to devote time and energy needed to become proficient at that task" (p. 121).

Although there are many who may agree with Wassermann's (1994) claim that "case method teaching can be effectively applied in virtually every subject area, at most educational levels" (p. 11), case-based instruction was not equally beneficial/meaningful for all learners in this study. By examining the responses of a variety of learners, we identified aspects of case-based instruction that were most valuable and most frustrating for this group of learners. These results provide important insights regarding how to design and structure case-based learning environments so as to increase students' valuing of both the case analysis approach and specific case analysis tasks.

Based on comments from these nine students, we suggest specific aspects of the case method that might be re-designed to optimize student learning. For example, when instructors are preparing to implement a case approach, they might begin by considering the following questions: Do students understand what they are supposed to do and why they are doing it? Do students perceive the relevance/meaningfulness of the cases/case method outside of the classroom setting? Are the cases perceived as being authentic and realistic? Are they interesting and enjoyable? Is there enough variety to keep interest and motivation high? Do students believe that they can master the case approach with a reasonable amount of effort? Are there opportunities to learn from mistakes and to learn from and with others? Are students involved in the design and selection of tasks? Are students permitted/ encouraged to make choices regarding how they learn? By designing case-based learning environments with these questions/concerns in mind, students may be better able to see the value which many educators believe is inherent in the method. Furthermore, it is expected that by increasing students' value for the case method, effective learning will be more likely to occur (Brown & DeLoache, 1978).

Limitations and Directions for Future Research

In addition to the small number of participants, several components of this study limit its comparability. First, this study described students' responses to one variation of the "case method." Students' responses might be expected to vary with the specific type of case/case method used. It would be useful to examine how differences in case design and purpose influence students' responses. Second, veterinary students may not be representative of students in other disciplines that use case methods. It would be important to examine the responses of students in a variety of disciplines. Third, in this study we observed one instructor's use of case studies in one content area and thus cannot separate specific effects due to the instructor from those due to the method, content, or participants. Perhaps if this instructor used a traditional method, students would still have responded as they did. Or perhaps, this group of students would have responded similarly to this and/or other instructional methods regardless of the teacher. Comparisons among students' responses to different instructors and different methods used by the same instructor might clarify this picture.

Conclusion

This study examined students' responses to case-based instruction by exploring the similarities and differences among nine students' experiences. Understanding how case-based learning is experienced by the participants requires in-depth interviews with a variety of students to gain their unique perspectives. It is our hope that, having heard the voices of these nine learners as they encountered the challenges and difficulties of an unfamiliar and demanding educational approach, educators will be in a better position to help future students effectively respond to similar demands.

One important implication of this study is the need to inquire into students' value for the educational tasks and methods they encounter. The fact that students responded differently to the same instructional method highlights the importance of attending to individual students' perceptions of, and responses to, classroom experiences. Although case-based instruction was highly motivational and engaging for some, it was a difficult and frustrating learning experience for others. Rather than assume that case-based instruction automatically works for all learners, it is important for educators to assess their students' initial perceptions and skill levels and then modify or enhance the case approach to meet their needs. By being aware of the effects that perceived value may have on students' responses, educators may be able to alter or eliminate potential difficulties before they become problematic. As Daloz (1990) reminds us, "Understanding the precise nature of the demands we make on our students and calibrating our expectations to their particular strengths and weaknesses is a special art" (p. 89) yet this is, after all, what all good teachers are expected to do.

It is hoped that the results of this study will help case designers and case teachers meet the challenge of supporting students in their efforts to become effective case learners.

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Title:

The Internet as a Tool for the Social Construction of Knowledge

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Abstract

The use of computers as a tool for learning has traditionally focused on individualized methods of instruction (Lumsdaine & Glaser, 1960; Saettler, 1990). Social interaction, however, is taking an increasingly important role in current learning theories and instructional prescriptions including computer-based delivery systems (Bruffee, 1993; Lave, 1988). Concurrent with these recommendations, global computer networks have emerged bringing new forms of computer-mediated social interaction. This paper discusses an ongoing case study that takes advantage of Internet technology to promote learning through socially-mediated interactions. Based upon theories of situated learning and cognitive apprenticeship (Brown, 1989; Collins, 1990), students engage in social dialog with experts through Internet technologies such as email, email redistribution lists (listservs) and the World-Wide Web.

Background

The use of computers as a tool for learning has generally focused on individualized methods of instruction (Lumsdaine & Glaser, 1960; Saettler, 1990). Largely influenced by behaviorism, traditional computer-based training reflects a stimulus-response approach. Highly structured and repetitive interactions delivering immediate feedback are still standard features within many computer-based learning environments. Approaches derived from the cognitive sciences (such as Intelligent Tutoring Systems) have also featured individualized instruction (Farquhar & Orey, in press; Sleeman & Brown, 1982). With renewed influences from philosophy, sociology and anthropology, epistemologies and theories such as social constructivism and situated cognition suggest new approaches for the design and implementation of learning environments. Concurrent with the arrival of these new perspectives, technologies have emerged giving us new capability to engage learners in structured social interaction.

New Perspectives

Social constructivism posits that individual constructions of knowledge derive from interactions with the social environment (Cobern, 1993; Tobin & Tippins, 1994). From this perspective, knowledge is continually constructed and reconstructed by the individual. The social environment provides a set of experiences from which the individual tests understanding and adopts group norms. Viable learning environments, from a social constructivist viewpoint, structure social interactions to support the development of personal meaning.

This philosophical position is consistent with situated cognition, a theory that describes knowledge as a relationship between cognitive and social factors (Brown, 1989; Streibel, 1994). The primary supposition of situated cognition is that knowledge exists only within context. According to this theory, an understanding of knowledge must include the artifacts, activities, participants, and interactions within a cultural setting. Orey and Nelson (in press) suggest that the theoretical position of situated cognition is a cross-disciplinary perspective involving ideas from both psychology and anthropology. Lave (1988), an anthropologist studying situated cognition, describes the everyday use of knowledge as "distributed - stretched over, not divided among - mind, body, activity and culturally organized settings."

While social constructivism and situated cognition are views with which to understand and describe knowledge, cognitive apprenticeship is an amenable methodology for the acquisition of knowledge (Collins, 1990). The cognitive apprenticeship model proposes that the design of learning environments reconstruct important attributes of master-apprentice relationships. Among other attributes, "apprenticeship embeds the learning of skills and knowledge in their social and functional context" (Collins, 1990, p.454). Authentic tasks and meaningful situations are required to bring novices into a culture of expert practice (Brown, 1989; Vanderbilt, 1990). Thus, situated learning is a recognized and employable feature within the cognitive apprenticeship framework.

The cognitive apprenticeship model makes a number of recommendations for the design of learning environments. In addition to providing a meaningful and authentic task, the model calls for reflection, articulation, collaboration, and multiple practice. Cognitive apprenticeship prescribes the implementation of these features through structured social interaction within a community - a process that Lave describes as "legitimate peripheral practice." Until the recent development of the global network, structured social interaction has not been an instructional approach easily supported by computer technologies. The ongoing study described in this paper has examined the implementation of cognitive apprenticeship strategies through the use of recently-available Internet technologies.

Study Context

Over a period of four college semesters a variety of Internet technologies were implemented by the researchers in four separate graduate-level courses. All four courses were related to the topic of training technologies, yet had a different focus. The majority of the participants (75%; n=58) were completing introductory courses in training technologies, while the minority were taking development courses in either computer-based training (15%; n=12) or video production for training (10%; n=8). Upon entering the courses, few subjects had prior experience with Internet technologies. The fall and spring classes met for one evening per week, while the one summer course met twice per week.

The technologies selected to support the strategies included personal e-mail among participants, e-mail distribution lists (listservs), synchronous "chat" communications, and the World-Wide Web. Consistent with the cognitive apprenticeship model, the strategies implemented were characterized by:

> Complex, problem-based scenarios were selected in order to situate or anchor knowledge within a variety of contexts.
>
> Articulation was encouraged through open-ended requests to propose, posit, or recommend.
>
> Reflection of personal experiences was encouraged through requests to defend and rationalize.
>
> Responses to scenarios by all parties were most often "published" or made available for all in a socially-mediated, consensus-building environment.
>
> Novices were encouraged to collaborate.

Data was collected through observations, records of electronic communications, interviews with selected subjects, and self-reports. This study, which continues through the present semester, intends to reveal how skill development can be supported or impeded by the strategies and technologies selected.

Procedure with Listserv & Email

The first technology implemented was electronic mail (e-mail) and an e-mail redistribution list (in this case known as a listserv). All students were given an e-mail account and a brief introduction to its use. A few students implemented e-mail capabilities from their home computer through either the University system or by subscribing to a commercial service.

All students were subscribed to a newly assigned listserv managed and controlled by the course instructor and lead researcher. Two special guests were regularly subscribed to the listserv with the specific responsibility to regularly respond to questions and comments as consulting experts in the field of training technologies. Brendan McGinty, now Vice President of Development & Operations with University Communications, has 20 years as a Computer-Based Training and Multimedia Developer. Carrie Kotcho serves Bell Atlantic as a Multimedia Developer and has 10 years of experience producing training videos and multimedia products. While introduced as "virtual guest speakers," the intent behind their participation was to include them as expert members of the community, or "mentors," to promote a cognitive apprenticeship relationship with classmembers.

Subscribers to the list were encouraged to introduce themselves and to post any messages that they felt relevant to the topic of training technologies. The two smaller classes were given specific assignments to introduce themselves to the list.

Assignments that involved use of Internet communications were characterized by an ill-defined problem, based-upon a real (or realistic) situation lacking in sufficient detail to render an immediate solution. Students were asked to propose a solution to the problem with the experts acting as either resources or clients. Figure 1 describes one of the given scenarios where Brendan McGinty, an expert in the implementation and application of the NovaNET CBT system, acted as a mentor. In most cases, teams were formed (from two to four students) to worked on problems with the request that they post all questions and responses to the list.

Results from Listserv and Email

The teams collaborated for a period of typically less than one hour before generating and posing questions for the expert. While the request was made to post all questions to the listserv, a few teams sent questions directly to the expert through his e-mail address. Reported reasons for this were both a misunderstanding of the directions as well as inadvertent or an unintended use of the e-mail system.

Nearly all questions posed by the students at this early stage of the assignment were lengthy descriptions of the problem. Most of the postings to the listserv were summaries of the given scenarios; one team simply copied the given problem description to the listserv with an additional question at the end.

With minor exceptions, the students reported that the problems were meaningful and relevant. On more than one occasion, a team admitted to intentionally forming some assumptions of the problem around their own work-related context or present need. Upon consultation with the instructor, one team generated their own problem directly from their present work environment.

Engineering Services Scenario:

A company providing a broad range of engineering services with headquarters in Raleigh-Durham, North Carolina, is dedicated to maintaining a highly-educated workforce knowledgeable in current technologies. The headquarters provides offices for 120 mechanical, electrical, and computer-science engineers. An additional 25 personnel are employed in managerial and support staff roles. Nearly all employees have a college degree, many posses graduate degrees.

The company boasts its support for the personal growth of its employees. Nearly all of its employees use computers in their daily activities. Computers are assigned to each employee and a number of regular workshops are offered in various software applications. Most company computers are high-end systems capable of running sophisticated modeling programs and are connected to various networks including the Internet.

The company requires that each employee complete 40 hours of training and development programs each year. Employees select programs through consultation with management. The majority of training programs provide employees with an opportunity to increase their engineering skills in a particular area or to broaden their skills to other areas. Unfortunately, the present training facilities are overbooked and understaffed. Many employees are waiting six months or more to schedule some of the more popular courses.

This company is seeking to expand its training programs, but is looking at cost-effective alternatives to simply providing additional training staff and space. So far, the company has not made use of CBT as a delivery medium. Would you advise the company to provide CBT? And, what services, if any, from NovaNET would you recommend that they provide?

Figure 1. Example problem for listserv discussion.

Responses from the experts to the initial set of questions occurred anywhere from one to five days later. The responses were most often lengthy discussions presenting several points. Since all responses to the questions were posted to the listserv, the experts would often refer to points made in their previous comments.

A couple of teams were able to develop their solution to the problem after only one interchange with the expert. Other teams, however, asked follow-up questions approximately one week later. On very few occasions did the dialog continue through three rounds of questions and answers. The lack of follow-up dialog through more than a single round of questioning was consistent in most dialogs on the listserv despite the researchers' intent, through on-line encouragement, to "keep the questions coming."

In class, students reported a respect for the experts and the information provided for them through the listserv. Additionally, students reported an interest in continuing a dialog with the experts with a few comments suggesting that the listserv dialog was "very short."

Procedure with Synchronous Chat

One small class (n=8) during the summer of 1995 was engaged in synchronous chat sessions with an expert centered on solving an ill-defined problem. In most cases, students were asked to propose a training video as the solution to a particular training problem. The chat was arranged through a commercial on-line service (America Online) due the availability of such service by the expert. The interface for the synchronous chat allows messages of no more than two lines to be immediately posted within a scrolling window.

Pairs of students were formed to respond to the expert's questions. Each pair was advised to collaborate on the problem prior to meeting the expert on-line. Some students were given a particular time and location for the chat, while other students who had subscriptions to America Online were left to arrange a time with the expert at their convenience.

Results with Synchronous Chat

The pairs collaborated for times ranging from 30 minutes to one-and-a-half hours, often immediately before their scheduled chat time. In all observed cases, one student from each pair took control of the keyboard for the 30-minute, on-line dialog. With other issues, a variety of approaches to the chat technology were observed. A few students typed many lines of background information before any interchanges with the expert took place. Others would address a point at a time, or would simply respond to questions placed by the expert.

Sentences, or single ideas, were quite often broken into several entries, obviously in response to the limitation of the interface. And, due to the time delay in posting these two-line responses, the order of display would not reflect the order of conversation. Figure 2 is an example dialog with this characteristic.

Expert:	I have produced Hazardous Communications videos and videodiscs for several companies
Expert:	but usually they are only concerned with labelling and safety gear. What are the objectives
Pair3:	Well then, I would not have to have spent so much of my precious time learning this editing equipment
Expert:	of this video.
Pair3:	and producing this video.
Pair3:	Employees will be able to have acces and know how to read MSDS sheets...

Figure 2. Example synchronous dialog.

This characteristic appeared to confuse both the novices and the expert when significant thoughts were left apparently incomplete until many moments later. The trailing notes caused students to re-read earlier entries in order to follow the stream of the dialog.

Without exception, students reported a high interest in the novelty of the chat technology. They also were so interested in physically meeting the expert, that the class took a road trip of 1.5 hours later in the semester to meet her.

Procedure with World-Wide Web

We are just beginning to use the World-Wide Web as a medium of social dialogue. While course materials for these classes have been provided on the web for over a year, the materials are generally information only and do not lead to dialog. Social discourse through the Web is being implemented in small ways; we have plans to implement more social discourse in the future.

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Presently, some questions related to the personal experiences, expectations, and contexts of the course are being asked of students. Students respond through a web page with fields or "forms". The responses get posted to the web site for the course for all other students to browse. Figure 3 is an example of one the questions posed through the web.

Personal and job-related context related to this course.

Many individuals who take this course have a computer and other resources already available to them. In addition, some individuals have an immediate need for computer-based training products at their place of employment. In order to improve our understanding of your context, please respond to the following questions.

- I have personal access to a computer for use with this class.
- I have Internet access from my personal computer.
- I have or will have personal access to the ToolBook authoring system.
- I have a project already selected for development.
  (Project description and context):
- For this course I'd like to convert, some portion of my Internet course to a multimedia format, and have it available on the Web...

Figure 3. Example Course Questions Posted to the Web

We have proposed additional software to take advantage of the multimedia and global networking capabilities of the web. The proposed software will provide instruction and support in the domain of performance technology. Users will investigate industry-related performance problems (e.g. production errors, complaints, low production) by conducting "interviews" and recommending solutions (e.g., provide training, increase rewards, remove obstacles.)

Students enrolled in courses at Penn State Harrisburg will be solicited for participation as well as students in similar programs at other institutions. Recognized experts and trainers in the field will be especially encouraged to participate.

Conclusions

It was the intention of the study to implement Internet technologies in ways that support and promote cognitive apprenticeships. In the opinion of the researchers, this was not fully realized. One central component of the cognitive apprenticeship model is multiple practice within the domain. The strategies implemented in this study failed to demonstrate a form of multiple practice that we expected to see in social discourse. We are calling this feature dialog momentum.

Dialog momentum is demonstrated by the continuance of a discussion upon an idea through several rounds of responses. It is best represented in electronic communications through threads of discussions with multiple listserv postings and personal correspondence. This feature was not well demonstrated in this study.

Both the listserv activities and the synchronous chat activities did not demonstrate dialog momentum to our expectations. Listserv discussions did not, on the whole, demonstrate multiple postings concerning single topics. Instead, discussions revolved around only a few postings. Within the chat feature, dialog certainly did consist of multiple responses. However, the disjuncted nature of the dialog meant that one had to constantly move backward, not forward in the discussion.

One of the major reasons that dialog momentum did not occur in the listserv, in the opinion of the researchers, is the result of the context of the study. Most participants had access to electronic mail only once per week as they attended their weekly class. Dialog momentum requires a faster turnaround of responses. Additionally, the synchronous chat session would have been greatly improved by faster response times. Slow communication response times was the major obstacle to moving the dialog forward.

In summary, present Internet communications such as listservs and synchronous chat sessions can be used to support instructional purposes. The use of on-line experts can aid the process by providing additional resources and points of view. True cognitive apprenticeships which require repetitive practice through the notion of dialog momentum are difficult to accomplish. More attention toward creating dialog momentum may deliver better results.

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Title:

The Impact of Gagne's Theories on Practice

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Robert Gagne's theories and research in instruction and learning have been discussed in other chapters, where their relationships to each other are explored in depth. Gagne's theories and research have had significant impact on practitioners in general and of instructional designers in specific, and this will be the focus of this paper. Given the length of his professional career, and the esteem with which his numerous publications are held, it is axiomatic that he has had an impact. Further examination reveals that he also has influenced teaching and curriculum development through his research and theory. He also used standard practices as a stimulus for the development of theory. Throughout his career, Gagne was always cognizant of the gap between theory and practice, and addressed this gap by directing his investigations toward practical problems.

I personally have felt the impact of Robert Gagne during my military training in the late 1950s and early 1960s. These were my earliest experiences as an adult learner and a teacher of adults. Reviewing the Gagne literature for this paper confirmed a suspicion I've had since these military experiences. There seems not only to be a possibility, but also a high probability, that my training was influenced in no small measure by Gagne and his associates in the military. I experienced first hand the effectiveness of military training based upon Gagne's principles as both a trainer and trainee. However, my interest in Gagne's influence on practice is more than an outgrowth of my military experience. That, in conjunction with 25 years as a practicing instructional designer in public schools, colleges and industry has created a somewhat personal relationship to Gagne and his contributions.

This paper will explore Gagne's influence on practice by first examining the relationship between theory and practice especially in relation to instructional design, and then discussing curriculum development and transfer of learning.

The Relationship between Theory and Practice

Gagne typically examined the interaction and dependencies between theory and practice. This is noteworthy given the attention that the application of theory to practice has also received by other researchers. The work of Huberman (1990), London (1973), Battersby (1987), Clark (1988), Schön (1987), and Willis (1993), are but a few examples of researchers who have joined the ranks of researchers who argue that good theory should be applied to practice, and conversely exemplary practice should be examined as a basis for new theory development. Huberman (1990) goes further in linking theory to practice by suggesting that researchers should start their research by first contacting practitioners. Furthermore, he notes that ". . . research findings can flow into practitioner settings and craft knowledge can move into research settings as a natural function of the ongoing relationships between both parties feeding more or less automatically into their customary transactions" (p. 387). This kind of relationship, although described by Huberman in 1990, seems to reflect many situations described by Gagne in his early work. For example, Gagne (1962), in his article "Military Training and Principles of Learning" discusses the differences between those learning principles studied in laboratories and their application to military training, and recognizes the difficulties of applying theory to practice.

> I am not asking, how can a scientific approach be applied to the study of training? Nor am I asking how can experimental methodology be applied to the study of training? The question is, rather, how can what you know about learning as an event, or as a process be put to use in designing training so that it will be maximally effective? (p. 84)

Gagne, as early as the late 1950s and early 1960s, had clearly established an interest in and desire to apply theory to practice. He was especially interested in examining the larger issue of applying theory to training, teaching, and learning with the eventual objective of making it more effective and efficient.

Gagne's early observations in military training, research, and academic laboratories provided ample evidence of the inadequacy of existing learning theories and principles as vehicles for solving pressing training problems, and the impact of his reactions to these observations was profound. For example, his theory and research findings were applied to the development of training on trouble shooting aircraft electrical systems and electronics. This is one specific area in which I experienced training bearing the earmark of Gagne's theories. The trouble shooting training I participated in (and later taught) was carefully sequenced hierarchically, and component tasks were intended as mediators that directed the instruction and learning process toward the ultimate objective. Military trainees were evaluated for mastery of prerequisite skills and taught or retaught these skills where necessary. All of these strategies reflect the influence of Robert Gagne.

Gagne's ever present concern with practice, even in the midst of theory development, continues to benefit education and training. These benefits will be explored here, especially in terms of curriculum development, instructional design practice and transfer of training.

Impact of Gagne's Theories on Curriculum Development Practice

An examination of curriculum and curriculum development logically begins with a concept definition. Gagne (1966) defines curriculum as

> . . . a sequence of content units arranged in such a way that the learning of each unit may be accomplished as a single act, provided the capabilities described by specified prior units (in the sequence) have already been mastered by the learner. (p. 22)

This orientation is a logical extension of his cumulative learning theory and his notion of the learning hierarchy.

Contrasting definitions illustrate the diversity of thinking in this area. For example, Bloom (1976) views curriculum as occurring in two forms--visible and invisible. The former being the school subjects one is taught, and the latter being those lessons which teach one his or her place in the world. Gagne's concept is closer to the first view.

Further contrasting definitions are offered by Bruner (1966)[2], Eisner (1985)[3], and Klein (American Society for Curriculum Development, 1993)[4]. Bruner and Klein provide views that are more traditional and closer to that of Gagne. Eisner, on the other hand, also recognizes the existence of both formal and informal curricula, similar to Bloom. While not all theorists agree on the definition of curriculum, Gagne's position has been used as the basis for a number of important efforts in schools and training.

School program design. The most pervasive example of an application of Gagne's theories and research to a large scale curriculum project is *Science: A Process Approach* (SAPA), which is part of the American Association for the Advancement of Science (AAAS) Commission on Science Education. These science curriculum materials were influential in schools and colleges during the 1960s and early 1970s and represent a significantly large scale curriculum effort utilizing Gagne's theories and research in the areas of problem solving and scientific inquiry. Gagne's view of a process approach to science is scientific inquiry and is based on students having a large knowledge base which they subsequently utilize to make and then test inductive inferences. The underlying foundation for the process approach is hierarchical, and presumes that learners have the prerequisite process skills as background. Gagne (1965) maintained that the process approach is a middle ground between the "content approach" and the "creative approach" and "It substitutes the notion of having children learn generalizable process skills which are behavioral specific, but which carry the promise of broad transferability across many subject matters" (p. 4). It can also be said that SPAP and its orientation to teaching elementary science and scientific inquiry, although first published in the sixties, remained immensely influential in science texts and other commercially published science materials well into the 1980s. Andrew Ahlgren of AAAS, co-author of *Science for All Americans*, provided further testimony to Gagne's influence on science curriculum, as well as his indirect influence on mathematics, and technology curriculum in specific (A. Ahlgren, October 3, 1994, personal communication). He stated that SAPA most certainly had tremendous influence on not only science, but also technology curriculum.

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[2] Bruner's (1966) definition is "A curriculum should involve the mastery of skills that in turn lead to the mastery of still more powerful ones, the establishment of self-reward sequences.
. . . a curriculum should be prepared jointly by the subject matter expert, the teacher, and the psychologist with due regard for the inherent structure of the material, its sequencing, the psychological pacing of reinforcement and the building and maintaining of predispositions to problem solving (pp. 35, 70).

[3] Eisner (1985) defines three curriculums: null, implicit and explicit.
Null: A curriculum in which all of those things not taught and not learned in schools--there simply are no opportunities to learn them.
Implicit: (This is similar to Bloom's latent curriculum). A curriculum in which ideas, values, attitudes, and processes are not explicitly taught; but they are none-the-less, learned. They are learned through the subtleties of teacher values and attitudes, as well as the signals sent by the organization as a whole (e.g., where it puts its resources, and what it values--sports, academics, fine arts, etc.)
Explicit: The curriculum to which students, teachers and administrators must attend to most in schools. It is what parents and society expect students to have learned, and what they try and measure as predictors of success. This curriculum offers tangible evidence of its existence through instructional materials, technology, instructional strategies, guides, etc. The explicit curriculum is often perceived as that cumulative knowledge of human kind which is passed on through the generations.

[4] Klein's (American Society for Curriculum Development, 1993) definition is "Curriculum is those activities, processes and structural arrangements as intended for, employed in, or experienced in the school and classroom for the purposes of fulfilling the educative function (p. 2.16).

Not all see Gagne's influence on science curriculum as positive. Finiley (1983), for example, argues that Gagne's theories, as well as others of like mind, have propelled science curriculum in the wrong direction by advocating a commitment to inductive empiricism.[5] He maintains that a presentation of papers by Gagne to AAAS ". . . has had a substantial influence on curriculum, instruction, and research in science education since that presentation" (p. 47). Finiley then selects Gagne, in view of all others writing about science process, as the most influential when he says: "Although many science educators have written about science processes, the view established by Gagne has been most influential" (p. 48). He continues his argument from a philosophical perspective indicating that Gagne, similar to his predecessors like Francis Bacon, Robert Boyle, Sir Isaac Newton and Hume, embrace the positions of empiricism and induction. Finiley, although in fundamental disagreement with Gagne's approach to teaching science, substantiates the overreaching influence Gagne has had on the development of science through SAPA during the late 1960s and into the 1980s.

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[5] Finiley, when discussing Gagne's theories is making direct reference to Gagne's influence on science curriculum through AAAS in general and SPAP in specific. The influence, as mentioned earlier, is centered around Gagne's perspective of a process approach where learners are taught to think and solve problems like a scientist would. In Gagne's (1965) scheme this would be accomplished b[5]Bruner's (1966) definition is "A curriculum should involve the mastery of skills that in turn lead to the mastery of still more powerful ones, the establishment of self-reward sequences.
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Hackett (1971) provides another example of the use of Gagne's theories on a large scale curriculum project in a public school setting. Although her work was primarily directed toward reading and communication skills curricula, she provides ample evidence of the application of Gagne's theories to social studies and mathematics as well. Hackett's experiments and curriculum projects focused on a performance-based approach which has many similarities to the outcome based education movement of the late 1980s and early 1990s.

There are also many examples of smaller scale curriculum efforts that apply Gagne's theory to curriculum development projects. Two examples are Gilbert's (1992) use of Gagne's hierarchies in his curriculum on questioning and taxonomies, and Lines's (1988) work with advanced economics. These programs provide evidence of more recent applications of Gagne's theories to curriculum. One can also examine as evidence Margaret E. Bell's (1982) article in which she makes a persuasive case for the application of Gagne's theories to designing programs. She argues that curriculum design and development has not been as systematic as the efforts of designing instruction. Bell recommends that Gagne's five capabilities can be applied to course instruction as well as program or curriculum development. John Flynn's (1992) also adapts Gagne's Events of Instruction to the very high profile and contemporary research area of cooperative learning.

School lesson design. When relating Gagne's theories to curriculum efforts that are directed toward individual lessons many of the examples utilize computer technology. Lesgold's (1987) effort wherein goal knowledge was examined as to its significance to ". . . intelligent machine . . . [and] human activity . . ." is an example of adapting Gagne's theories to curriculum and prerequisite skills in a novel way. Also in this category is the Smaldino and Thompson (1990) research relating the Events of Instruction to science education and computer technology. These authors propose designing science lessons focusing on the "Nine Events of Instruction" (p. 17). Jonassen (1988) has utilized many of Gagne's writings, theories and principles in the design of microcomputer courseware. He especially utilizes Gagne's Events of Instruction and his work in the area of hierarchies and prerequisite skills. Jonassen (1988) also utilizes Gagne's work with respect to learning outcomes in designing individual lessons to be delivered by computer courseware.

Training curriculum design. Gagne's theories also have been used extensively in training curriculum design in the private sector of business, or the non-school sector of governmental agencies. It is most appropriate to start with the military and defense related environments where the evidence of Gagne's influence abounds. While many of Gagne's early writings are generously sprinkled with references to military applications and research results conducted in military settings, there are also many current applications made in private sector training. Stepich (1991) and Garavaglia (1993) provide two examples. Stephich (1991) examines the idea of utilizing training to move learners from novice to expert status, and proposes a way to apply Gagne's "conditions of learning" to training design. Garavaglia (1993) suggests that designers take another look at the design phase of Instructional Systems Development (ISD). Garavaglia contends that: "For each event of instruction you should determine the method for which it can be achieved and the media necessary to achieve it" (p. 28). He continues by expanding on how the Events of Instruction can be used in conjunction with Kellers ARCS model in what Garavaglia's calls a technical training submethodology. Both of these articles utilize Gagne's theories to develop techniques, methods or practices and each imply that the practice based upon his theories has implications for a larger curriculum effort throughout a training program in the private sector.

Impact of Gagne's Instructional Design Theories on Instructional Design Practice

The profound influence of Gagne's theories on instructional design practice is most easily understood when positioning them into the context of his early theories of instruction or learning.[6] It is important to realize that he was

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[6] The influence of Gagne's theories on instructional design practice reveals two paths which are not only interrelated, but nearly inseparable. The first path is an analysis of textbooks and handbooks. The instructional design textbooks and handbooks serve many purposes, one of which is to provide a communication link between theory, research and the practice of instructional design in education, educational psychology and training. The argument here is that there are two important goals for texts and handbooks. First, to communicate to the readers' the theories and models found within them; and second, to promote these theories in the respective practices of education and training of their readers.

The second path is an examination of the practical research reports, journal articles and curriculum projects which report the findings of research, theory development and application to instructional design practice. These resources are more likely to be, in relation to this paper, reports on the application of Gagne's instructional design theories to specific content one of the theorists instrumental in bridging the gap between the behaviorists of the 1950s and 1960s and the cognitivists of the 1970s and 1980s. Case and Berither (1984) maintain that when Gagne ". . . shifted the focus of attention from the *how* to the *what* of behavior change; that is, he shifted the focus from reinforcement to the nature of the behaviours themselves" (p. 144).

Case and Bereither (1984), suggest that Gagne not only moved away from reinforcement, but he also recognized learning as a more complex process than previously thought, and they elaborate on Gagne's recognition that learning was not confined to ". . . the learning of physical behaviors and simple stimulus-response connections but also the learning of concepts, rules, principles, intellectual skills and cognitive strategies" (p. 144). Using Gagne's earlier work as background, they suggest that the third and most important part of his work, which catapulted him beyond the behaviorists of that time, was his concept of sequencing intellectual skills and allowing the instruction to move systematically toward higher-order skills all while building on prerequisite skills.

Gagne had a part in the paradigm shift from behavioral to cognitive psychology in the early 1960s, and this brought about a predictable change in both instructional design literature and practice. The literature of the field, viewed as a communication link or mediator between theory and practice, is certainly a measure of just how pronounced his influence has been.[7]

Richey (1986) maintains that Gagne has had tremendous influence on instructional design practice through his theories, models and procedures for developing instruction. Instructional designers have embraced Gagne's theories for many reasons; however, one of the most compelling reasons lies in his work with learning outcomes. Gagne (1988) directs the instructional designer to utilize the following learner outcomes when analyzing content: intellectual skills, verbal information, cognitive strategies, motor-skills and attitudes. Subsequent to determining the desired learning outcome, the instructional designer is advised to complete the content analysis based on the expectations for the learner. The documentation of the design process where the designer selects the appropriate learner outcomes, completes the content analysis and develops the appropriate flow diagrams and procedures becomes the core of the instructional design document used to guide the instructional design project to completion.

No examination of Gagne's influence on practice would be complete without examining the influence of his theories on teacher education and ultimately on teachers, professors and the entire education enterprise. Furthermore, this examination compels the researcher to delve further into the definition and concepts of influence and change. Short term

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areas or disciplines within the educational or training arena. Since the author devoted considerable space and cited several sources from this path when examining Gagne's influence on curriculum, no further effort will be made to elaborate on these items. It is clear however, that Gagne's impact on instructional design practice is evident in the enormous number of journal articles, research reports and curriculum projects which refer to his work. The reader is well advised to pursue these resources or to refer to the curriculum section of this paper for further information. No specific effort has been made to identify when resources from one or another path are being highlighted other than to identify items as books, reports or journal articles.

[7] Textbooks and handbooks are a primary communication link between theory and practice, and as such they are an essential resource for measuring Gagne's influence. Among his texts are the following: the four editions of Gagne's The Conditions of Learning (1965), the two editions of Gagne and Briggs (1974 & 1979), Principles of Instructional Design and the third edition of the same title by Gagne, Briggs and Wager (1988). These books alone would indicate a monumental impact on instructional design practice since they are cited throughout the instructional design literature that parallels them, and almost all the instructional design literature that follows. They are also texts from which many instructional design practitioners in the 1970s and 1980s learned the theory and practice of instructional design.

There are several series of texts which further explain and apply Gagne's theories for practitioners. An example of a multiple series of texts is Dick and Carey's (1978, 1985, 1990), The Systematic Design of Instruction, with a fourth edition in press. There are very few practitioners anywhere haven't taken a course where this text was used, applied it to their practice, taught from it, or at least read it in part. Although the Dick and Carey editions can be characterized many ways, they are theoretically "vintage systems theory" with the strong influence of Gagne in their application of instructional design theory to practice. They also model Gagne's desire to be practical by presenting their system for designing instruction as one that accommodates either a "knowledge" or "product" approach. They add that they favor the product approach since it requires students to actually develop instruction as opposed to learning about instructional design as a theoretical concept. There are many other series and single texts which have been influenced by Gagne's theories and research, and one worthwhile consulting to this end.

change in attitudes brought about in pre-service educators being exposed to Gagne's theories in methods and media/technology courses may be assessed traditionally in course evaluations and tests; however, expecting them to incorporate these theories and concepts into their teaching practice is a different matter. This is especially true when considered from the perspective of initiating permanent change on professionals who ultimately spend their careers in an organizational culture which has many years of history, precedence, and accepted methodology, which often reinforces the attitudes of experienced teachers, and shapes the attitudes of new teachers. Martin and Clemente (1990) argue that instructional systems design (ISD) has had minimum impact on schools because professionals as well as professors of ISD haven't considered carefully enough their clients (teachers) and the culture of schools. They further argue that until we (ISD professionals) understand that the accepting of the ISD approach would be considered an innovation in schools; therefore, subject to all the usual barriers to accepting change in the culture or social setting we will be unsuccessful in promoting ISD in schools.

Are we to conclude then that Gagne's theories have had little or no influence on teachers, professors and subsequently education:? Not necessarily! While it is true that there has not been a preponderance of teachers or educational systems adopting ISD in its entirety, there is evidence that teachers adapt ISD theories to their practice. In so far as Gagne's influence is concerned these adaptations are frequently made to ISD theories that often have his instructional theories embedded within them. A persuasive argument can be made that in implicit and often small ways, over an extended time period, teachers and professors exposed to ISD theories, models and procedures adapt them to their practice rather than adopt them. These adaptations bear resemblance to both Gagne and general systems theory. Planning proceeds from problem identification writing objectives and flow charting to sequencing content and concepts from simple to complex forming the basis for using lower level intellectual skills as a foundation for higher order skills, culminating with assessment. Given that this argument is lodged on the premise that the texts used in educational media and instructional technology courses for preservice teachers have been and continue to be strongly influenced by general ISD theories which have Gagne's theories embedded in them, it is recommended that the reader examine these texts and their potential in relationship to Gagne.[8]

Finally, teachers at the K-12 level, as well as those at the college and university level, have tremendous responsibility for instructional design albeit much less formal than professional designers might be accustomed to or prescribe. Therefore, the exposure to instructional design this group receives while participating in education courses utilizing the theories of Gagne and other theorists has the potential to significantly influence the course and unit design these practitioners engage in throughout their careers. The large number of pre-service teachers in the United States who take media and methods or instructional technology courses provides evidence for the potential impact of these teachers adapting Gagne's theories and models in their practice. Although, as mentioned earlier, the adapted instructional design practiced by teachers, instructors and professors is, on the surface, often less systematic and formalized than the instructional design models recommended in Gagne's books, nonetheless it does qualify as designing instruction. Instructional design theorists and researchers would be well advised to consider preservice teachers and their professors as one of the many types of instructional designers. In so doing the texts written for them might acknowledge organizational differences within which these professionals work and subsequently influences how they design instruction. Furthermore, these texts might then incorporate only the most practical and useful aspects of design theory from researchers such as Gagne.

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[8] The flagship texts in terms of practical application to preservice education are the Heinich, Molenda, and Russell editions of Instructional Media and the New Technologies of Instruction (1982, 1985, 1989, 1993). The third edition of the Heinich et al. is the first to mention Gagne's theory explicitly as widely accepted and recommended for the design of instruction; however, there is also ample evidence of implicit use of his work in the first and second editions. This, and other books in this genre, target an audience of preservice teachers primarily at the undergraduate level; however, they are also used at the graduate level as introductory texts in teacher education and instructional media programs. Their goals focus on providing their audiences with information, techniques, utilization, ideas and examples related to instructional media and the use of technology in education. These texts have had influence not only by mentioning Gagne's theories (although that is significant), but also by the fact that the professors, instructors and trainers of these courses use these texts. As professionals they have had wide exposure to Gagne's theories through their education as well as teaching multiple courses utilizing his work. These books often apply and model Gagne's theories and writings at least in implicit ways, and sometimes explicitly. This is clearly the case in the third and fourth editions of Heinich et al. (1989, pp. 42 & 53) wherein they cite Gagne and Briggs (1988) and Gagne (1985). Furthermore, the instructional design model recommended in these texts, and especially in the third and fourth editions, has many elements of Gagne's theories and is similar to other Gagne instructional design models.

Summarizing, the influence of Gagne's theories on instructional design practice spans a gap from a reliance on behaviorism as a foundational theory to the eventual adoption of cognitivism as an underlying theory. Further, Gagne's overwhelming influence on the literature read by practitioners and the researchers who teach them has had significant impact on practice. Finally, the indirect or implicit influence Gagne has had on the informal instructional design practiced by teachers and many professors through texts for preservice education is greater than many writers realize.

Gagne's Influence on the Transfer of Learning

When reading Gagne's work, and especially the four editions of The Conditions of Learning, one is impressed with his attention to detail related to the many dimensions of learning and transfer. Gagne discusses often that learning should be generalized to new and varied content and applied to situations in the learners life. Syllogistically, the argument could be made that through the four editions of The Conditions of Learning, and through his work with the Events of Instruction, Gagne always had been, and continues to be, dedicated to both near and far transfer.

Gagne (1989) was experimenting with the transfer of training as early as the late 1940s. This early research examines positive and negative transfer and discusses transfer in the context of giving: ". . . different amounts of training to separate groups of subjects on an initial task which was a subordinate part of a total skill involving four differential manual reactions" (p. 22). This research was done with training subjects on complex motor tasks using multiple trials and observing them for periods of little or no improvement (plateaus) in learning. In this study the control group performed better than the group with too few trials (negative transfer). The control group was outperformed by the group having optimal trials (positive transfer). Positive and negative transfer are defined in many ways; the following eclectic definitions suit this discussion.

> Positive transfer occurs when learning one task assists in the performance of another; or when a previously learned task enhances the ability or performance in another task or control group.
> Negative transfer occurs when the learning of one task impairs the learning of another; or previously learned task is an impediment to performance; or experimental group is outperformed by the control group.

It is predictable that Gagne's view of transfer would parallel the previous definitions at that time in his career given the influence of early behaviorists like Pavlov, Guthrie, Tolman, Skinner and Thorndike on his work. Further, his work involving positive and negative transfer became the basis for his later concept of transfer which has been so thoroughly embedded in the practice of instructional design.

The discussion that follows is centered on Gagne's evolving concept of transfer over a 20 year span. During that time frame his use of the term was modified from one which differentiated between positive and negative transfer to the more contemporary lateral and vertical concepts found throughout the literature and utilized by practitioners today.

Gagne (1962) in later references to transfer builds on the concepts of positive and negative transfer. When discussing transfer in the context of ". . . transfer of training from component learning sets to a new activity which incorporates these previously acquired capabilities" (p. 364) he seems to be directing his focus more toward generalization, which becomes the focus of his later conceptualization and subsequent definition of transfer. Gagne (1965), when discussing external events and the conditions of learning indicates the need for what has been learned to be ". . . generalizable, and transferable . . ." (p. 206) to new and different situations where it might be applied.

Gagne (1970) says that capabilities learned in school should provide students with the background and skills to accomplish practical things in their lives or in occupations and identifies this as lateral transfer. Furthermore, he says students should be able to learn more complex things as a result of their previous learning. This learning of more advanced or complex tasks or skill based on subordinate rules or concepts is called vertical transfer. The defining of lateral and vertical transfer within the framework of the conditions for learning helped establish the foundation for applying the concept of transfer to contemporary instructional design practice.

Some of Gagne's lesser known theories of learning and instruction are both an indication of his continued search for unique ways of solving learning and instructional problems, and his willingness to examine the contrasting work of other researchers. Gagne (1968) offers the cumulative learning theory to those practitioners having some difficulty with total acceptance of his hierarchical or taxonomical theories. Although hierarchical in the pure sense, the cumulative learning theory offers a modified approach to learning and transfer. His explanation of this theory begins with his contrasting two models of intellectual development, one by Hall and Gessell and another by Piaget. Gagne also examines two kinds of capability change, both of which are observable and distinguishable by the time frame required for the change to take place. Those changes in behavior capabilities that occur in hours, days, or weeks are referred to as learning and memory; those behavior capability changes requiring months or even years are called development. One of the many questions surrounding the difference between learning and development is that each view transfer of learning from a different perspective.

Additional examination of Gagne's theories related to human development reveals his Cumulative Learning Model and its relationship to transfer. Gagne maintains that using this model, which begins with S-R connections, and proceeds through concepts and simple rules and culminates with complex rules, will enhance transfer. In other words, learned capabilities at any stage of the model will not only transfer to further enhance the intended learning (i.e., the content for which the hierarchy was originally designed), but may also serve to transfer to new but related tasks. Gagne (1988), when referring to "stages" or "levels" in reference to learning new material related to previously learned material, states:

> Cumulative learning thus assumes a built in capacity for transfer. Transfer occurs because of the occurrence of specific identical (or highly similar) elements within developmental sequences. (p. 338)

Gagne, adds that "elements" has specific meaning in this discussion of transfer since it refers directly to ". . . rules, concepts, or any of the other learned capabilities . . ." (p. 338).

However, the larger question here is: do instructional designers, engaged in the process of practicing their skills and selecting learning theories automatically consider cumulative learning as a theory? The author's bias leads him to the conclusion that a large percentage of practitioners are not familiar with it much less utilize it in their practice to enhance transfer. Designers familiar with theories which are not "mainstream" whether Gagne's or others face the dilemma of: going back to what they know best, or experimenting with fresh approaches at a time when deadlines are shorter, and there is increasing pressure to decrease the time of the design cycle.

When considering Gagne's transfer theories and their relationship to intellectual skills and higher order capabilities, it is evident that Gagne accepts the proposition that intellectual skills and higher order capabilities may be learned for a specific intent or objective. These then become the background for generalization or transfer to other or new learning. The generalizations made by the learners may be a result of planned instruction, while in other cases they may (based on need or curiosity) take the initiative to learn independently. Since learning ascribed to this theory is cumulative, it often becomes more complex in the process of development; therefore, generalization and transfer between and among those things already learned and/or those to be learned is enhanced. Gagne (1988) when commenting on the process of transfer says: "There is no magic key to this structure--it is simply developed piece by piece. The magic is in learning and memory and transfer" (p. 332).

Summarizing the preceding definitions and discussions of transfer and their implications, Gagne's perspective is clear: the most important aspect of transfer is its dependency on what has already been learned. In short, there is nothing to transfer if it hasn't already been learned. The second criteria, and equally important to transfer, is the necessity to vary the situations and possibilities in the environment that the learner is expected to generalize the learning.

The concepts of far and near transfer have significant ramifications for instructional design practitioners since the design process is grounded in the application of learning both immediately after education or training or in the future as learners continue their education or employment. Far and near transfer are similar to Gagne's definition of lateral and vertical transfer, their similarity can be found through examining the functions of time, learning of subordinate skills and content complexity. Near transfer is concerned with application of instruction similar in complexity to the immediate future, where far transfer has the expectation of generalizing or applying learning over a longer time frame, and often in varying situations and contexts to the original training. A similarity between near and lateral transfer can be found in their expectation of applying concepts and procedures to problems or situations equal in complexity to those practiced in the instruction. Moreover, both vertical and far transfer have the expectation that the learner apply their learning over time and to new concepts and problems often to those more complex and unlike those presented and practiced in the original instruction. This brings the discussion to the internal dimension of both vertical and far transfer. Vertical and far transfer rely on the learner having mastery of a variety of knowledge, information and skills which in turn enhances the possibility of transfer occurring. The practicing instructional designer, through their design of the instruction, should build in a positive environment for learning. This environment should not only allow, but also strongly encourage, learners to experience "real life" situations in their instruction and to rehearse their perceptions of the concepts and information with other learners while they are being taught.

Although most researchers and theorists in the domains of instructional design, educational psychology and education support the concept of transfer, there are those who question the underpinnings of the transfer theories posited by Gagne and others of like mind. Singley and Anderson (1989) have written an entire book addressing transfer from the perspective of enhancing the probability of it occurring in the area of cognitive skills. Although they have devoted considerable effort to their investigation of transfer, Singley and Anderson question some of the premises related to vertical transfer and the effectiveness of hierarchical analysis and the identification of prerequisite skills as a method for enhancing transfer in curriculum design. They don't rule out the possibility of the success of this method; however, they question the effectiveness of it and recommend more specific research in this area.

Application of Gagne's transfer theories to contemporary instructional design practice are many, but few are any clearer than Dick and Carey's (1990) discussion of goal analysis and subordinate skills analysis. They suggest that designers can easily be misled by focusing on what learners need to know rather than what the learner must do. Furthermore, they insist that when analyzing subskills, the designer must ask what is it that the student must already know how to do, the absence of which would make it impossible to learn this subordinate skill? The utilization of this rhetorical question to illustrate a point related to transfer of learning, is a clear indication of the impact of Gagne's work these authors and subsequently on instructional design practice given that it is found in what was described earlier as a high profile and widely used practitioner text.

Summary and Conclusions

Attention here will be directed toward bringing closure to the discussion of the lasting influence Gagne's theories have had on practice. Further discussion of salient research, theories and practice presented in the paper will be included.

Perhaps the best place to start is with Gagne (1989) himself. In the Preface to Studies of Learning: 50 Years of Research, Gagne says:

> Learning theory has maintained its interest for me over many years. However, the questions addressed in my research have usually been practical ones, or at least have been strongly influenced by practical considerations. (p. 6)

This statement and others made in the preface of his book reflect Gagne's perception of his efforts to use research and theory to solve practical problems. As Gagne nears the end of the preface, in what appears to be an introspective comment about life choices, says: "My move to Florida State in 1969 was the beginning of a concentrated effort devoted to teaching and writing in the field of instructional design" (p. 6). Gagne seems to be acknowledging here that his intention was to link his vast research and theory base in instruction and learning with learners and the profession through teaching and writing.

Gagne's perception of his life's vision seems to be one of research and writing which initially focused on learning, and eventually, moved toward important contributions to theory. Gagne has, through his unwavering examination of the practice of instruction and applying it to how human beings learn, contributed greatly to the building of a foundation for the field of instructional design. Clearly his interest in learning in schools, as related to curriculum, and the examples he used to illustrate his theories are evidence of his interest in applying his theories to practice. His evolution from experimental psychologist to an instructional and learning theorist, whose focus became one of application of cognitive theories to instructional design, is indicative of not only his flexibility, but also his interest in instructional design practice. His place in the history of instructional design practice is most certainly secure from both a foundational as well as an applicational perspective.

Concluding from the examination of Gagne's influence on curriculum it is clear that his work has been significant. Evidence of his influence can be found in the many applications of his theories and research to a wide variety of content areas, age levels and learning environments. Additionally, his theories have withstood the test of time having been applied to curriculum of various types over the course of 50 plus years. As mentioned earlier his influence on the curriculum of science has perhaps been most broad based, long lasting and nationally acclaimed.

Questions remain as to how Gagne's theories will endure in light of the many available and competing theories that practicing instructional designers, curriculum specialists and educators now have as options when designing instruction.

A partial answer might be found by revisiting an interview Gagne had with the editor of Educational Technology in 1982. The editor asked Gagne if he thought instructional design would eventually transition entirely from behaviorism to cognitive psychology or would there remain a behavioral presence. Gagne responded by saying:

> I think that designers who work with cognitive learning theory in mind really incorporate the important parts of behavioral theory. Therefore, I think the answer to your question must be "yes." I do believe that the cognitive approach will come to dominate, if it hasn't already. (p. 580)

Does Gagne's response, from 13 years ago, offer us any clues to lasting impact of his theories in light of the large theory base available in the mid-90s? The answer is: a qualified yes, since designers are often pragmatists in their everyday practice of instructional design. Subsequently, they will select those theories and elements of theories, that seem logical and have a high probability of working in the situations and environments they find themselves.

A final comment on Gagne's future influence on curriculum must take into account the writers, researchers and theorists in curriculum publications. These documents would lead one to conclude that constructivism will be the dominant force in curriculum construction in the nineties. Earlier, when discussing curriculum, it was noted that Gagne was cited only once in the 1991-94 ASCD Handbook while constructivism and situated cognition were cited often. Furthermore, the ASCD publications have generous citations, methods, and corresponding activities that are very situated or constructivist in nature.

Returning to Finiley's work may offer another perspective for the reader. Finiley's criticisms of Gagne in 1983, which were fundamentally philosophical, might have been harbingers to the late 1980s and early 1990s. One thing seems clear, if the differences between constructivist philosophy and the inductive empiricism of Gagne are perceived to be irreconcilable by a majority of the theorists, this may, eventually, decrease Gagne's influence on instructional design practice and curriculum construction. However, another scenario may be, that practitioners will utilize Gagne's theories more selectively.

The genesis of Gagne's theories found their way into my practice before I knew they existed or what they were, and 10 years before I heard the name Robert M. Gagne. I learned from the instruction, which I believe was designed using his theories, because it was logical, provided me with enough practice to reach mastery and subsequently be successful. I taught from the instructionally designed materials which utilized his theories because they were comprehensive, well planned and worked. I continue to utilize his theories, selectively, 25 years later, as a significant part of my practice for many of the same reasons. Gagne's theories will continue to evolve as scholars analyze his work in search for new meaning. Gagne has a lasting place in the future of instructional design and educational practice. His theories and positions will undoubtedly be reinterpreted, modified and expanded, but his prominence will remain.

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Title:

Competencies Needed to Design and Deliver Training Using Instructional Technology

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Training professionals perform in a great variety of roles as they apply their competencies to the human resource development challenges facing their organizations (McLagan, 1989). Two primary duties of trainers include designing and delivering instruction. Each of these duties is becoming more challenging as technology evolves. The use of technology in training has grown tremendously over the past five years; tools have improved and have produced several changes in the way training is being designed and delivered (Haag, 1993). Contemporary design and delivery systems include computer-based training systems, multimedia systems, electronic performance support systems and telecommunication systems for distance learning. In addition, computer technology is being used to enhance traditional classroom training.

Although not every organization has implemented these new design and delivery systems, the number of organizations using these systems increases each year. A recent survey of organizations with more than 100 employees indicated that 48% are using computer-based training, 27% are using multimedia systems and 43% are using some type of distance learning system to deliver training (Industry Report, 1995).

The use of technology-based delivery systems in the training process has many potential benefits for organizations. For example, the use of computer-based technology in the design and delivery of training can result in greater learning gains, more consistent and acceptable job performance, enhanced cost-effectiveness and greater flexibility regarding the time and locations of training (Hannum, 1990). Several research studies have concluded that, under the right circumstances, computer-based delivery systems are considerably more cost effective than classroom training and produce learning that is at least equal to what can be achieved in a classroom (Haag, 1993). Technology can also help when addressing the needs of geographically-dispersed trainees and in reducing the need for classroom facilities (Perlstein, 1993).

However, the value derived from the use of technology in training is not due to the hardware itself but rather to the instructional processes that technology can support (Hannum, 1990). To be effective in their positions, today's trainers must possess competencies needed to perform in an increasingly technological environment. They must have a solid understanding of learning theories and methodologies and be able to apply this knowledge to the development and delivery of training using computer-based technologies, distance learning systems and other types of instructional technology (Hannum, 1990). Trainers who lack these skills may be limiting their effectiveness and their ability to obtain positions or advance in many areas of the field.

Developing and maintaining expertise in instructional technology can be a challenge to trainers for many reasons. Because instructional technology is an emerging field, many of the concepts associated with this field, including "multimedia" or "distance learning," have taken on a wide range of meanings, resulting in confusion for practitioners (Anglin, 1991). Also, because many of these technologies are still evolving, there are few standards in the field. The hardware and software associated with these technologies is continually being changed, upgraded or replaced. It is often difficult for both new and experienced trainers to design, develop and implement hardware and software in a timely manner when the technology environment is dynamic and the rate of obsolescence is increasing (Anglin, 1991). Finally, many trainers who have spent several years using traditional training methods and media may resist or feel uncomfortable with new technology (Schaaf, 1992).

There is a need for a better understanding of the competencies required by trainers regarding the use of new technologies in training and how these competencies may be developed. Although there have been several needs assessments conducted to identify the competencies of trainers, including the American Society for Training and Development's *Models for HRD Practice* and the competency studies published by the International Board of Standards for Training, Performance and Instruction, typically, studies of this type do not provide any detailed information about the competencies needed to use specific types of hardware, software or delivery systems.

Currently, there are several resources that could provide training to trainers who need to develop their knowledge, skills and abilities in designing and delivering instruction using contemporary instructional technology. These resources include undergraduate and graduate courses at colleges and universities; courses, workshops and certificate programs offered by trade schools or technical colleges; and conferences and seminars offered by professional associations (Lindstrom, 1994). Many hardware and software vendors also provide training to organizations that purchase their equipment and products. Finally, trainers can train themselves using training courseware, computer tutorials, videotapes, books and manuals (Lindstrom, 1994). However, because these programs and resources are relatively new, no statistics exist regarding the percentage of trainers who complete formal or self-paced programs or how successful these programs are in meeting the needs of trainers.

In addition, even trainers who are highly skilled in the use of instructional technology may experience difficulty when implementing new types of delivery systems in the work environment. There are often barriers in organizations that inhibit the successful implementation of instructional technology in training. These barriers may include high costs, lack of management support, lack of trainer skills, cultural defaults for the classroom experience and failure to identify needs adequately (Gery, 1994).

Statement of the Problem

Little is known about the nature of the challenges encountered by trainers as they attempt to incorporate computer-based technologies and distance learning systems into their training processes and programs. Few studies have examined the impact of these technologies on the role of the trainer.

Purpose of the Study

The purpose of this study is to provide current information on the implementation of instructional technology in employee training and the competencies needed by trainers to utilize instructional technology in their jobs. This information may be used to assist training professionals in determining their continuing education or training needs in the area of instructional technology. The information also may be used by universities, professional organizations and others who provide degree programs in human resource development or instructional technology in developing relevant curricula.

Research Questions

This study sought to find answers to the following questions:

1. What types of computer-based technologies and distance learning systems are being used to deliver training in business and industry?
2. What types of computer-based technologies and distance learning systems will be used to deliver training in the future?
3. What are the competencies that are needed for trainers to deliver instruction using computer-based technologies and distance learning systems?
4. Where are trainers obtaining the competencies that are needed to deliver instruction using computer-based technologies and distance learning systems?
5. What barriers exist in the workplace that prevent trainers from using computer-based technologies and distance learning systems to deliver training in the workplace?

Significance of the Study

Technology has dramatically changed the way can be which training is designed and delivered. These technological trends necessitate that training professionals learn new job skills (Lindstrom, 1994). This study was designed to benefit training professionals, human resource development managers, academicians and other training providers by providing practical, timely information that may be used to update trainer skills and training programs. This study will provide current information on the implementation of instructional technology in training efforts at a time when it is crucial for trainers to expand their repertoire of skills in this area.

In order to best prepare training professionals with the necessary knowledge, skills and competencies, training providers need to have an accurate picture of the current skill requirements (Morlan & Lu, 1994). The findings of this study may be used by universities and other organizations to develop and revise degree programs, courses, seminars, workshops, and self-study materials to meet the instructional technology training needs of human resource development professionals.

Methodology

This study was conducted during a six-month period from June to December in 1994. First, a literature review focusing on the use of instructional technology in training was conducted. Next, a questionnaire was developed by the researcher and reviewed by a group of eight trainers, research consultants and experts in the field of instructional technology. The first section of the survey was to contain demographic items, including job title of respondent, type of organization and size of organization where the respondent is employed. In the second section, respondents were to identify (a) how technology is currently being used to design and deliver training in their organizations, (b) their perceptions of the types of technology that will be used to design and deliver training in the future, (c) the level of competency required of trainers in each type of technology, and (d) sources of competency development in each technology In the third section of the survey, respondents were asked to identify barriers in the workplace which limited the implementation of instructional technology in training.

Population and Sample

This study was designed to determine the perceptions of training professionals regarding the use of technology in the design and delivery of instruction. The population selected for this study included members of the National Society for Performance and Instruction, specifically those members living and/or working in the following Midwestern states: Illinois, Iowa, Michigan, Minnesota and Wisconsin. This group was selected over the other professional training associations because of its focus on performance technology. The association's 1993-94 national membership directory was used to obtain a list of members of the population for this study. In this directory, members were listed alphabetically by state. In the five Midwestern states included in the study, there were a total of 1,093 members. A systematic sample of members was selected. This method of sampling is appropriate when a list of elements is available and when the list is arranged in a manner that will not interfere with the purpose of the study (Babbie, 1990). This method also assured that a proportional number of individuals from each of the five states would be included in the sample.

The following steps were taken to determine the size of the sample. First, a decision was made to establish a confidence level of 95% (0.95) for the results of the study. Then the formula outlined in *How to Determine Appropriate Survey Sample Size* (Narins, 1994) was applied to calculate the appropriate sample size for the population. For a population of 1,093, a sample of 381 was required to produce the desired confidence level. This method of determining sample size was generous and provided latitude against typical sources of error including non-response. The first member was chosen at random from the list of members in the designated five-state area. Then every third member was selected until the sample had reached the desired size.

Instrument Development

Given the purpose of the study, the research questions to be answered and the size of the sample, a mail questionnaire appeared to be the most economical and appropriate data collection technique. The instrument was developed through a careful examination of similar studies found in the review of literature. The instrument was designed to collect data as a self-administered questionnaire.

The instrument consisted of an 11 x 17-inch sheet of paper which was printed on both sides and folded into a four-page booklet. The body of the questionnaire was divided into three sections. In the first section, respondents were asked if their current position involved designing, delivering or managing training. At this point, individuals who were not currently working in the field of training and development were instructed to send back the survey without answering the remaining survey items. Respondents who were currently employed in the field were instructed to provide other demographic information, including their job title and the size and type of their organization, and to complete the remaining three pages of the survey.

The second and third pages of the survey contained a grid that listed 32 types of instructional technologies divided into categories. These categories included computer-based training systems, multimedia systems, electronic performance support systems, virtual reality, distance learning systems and computer presentation systems. Additionally, five areas were further divided into subcategories. In each category and subcategory, respondents were asked to identify if they used each technology in their training efforts and if they planned to use each technology in the next three years. They were also provided with an option to list additional technologies which were not included on the questionnaire.

In this same section, respondents were asked to assume that their organization planned to use each technology and to identify the levels of competency that would be needed to implement the technology. The levels included the ability to use or assist trainees in the use of a particular technology, the ability to assess the effectiveness of a technology, the ability to select a technology for an organization and the ability to develop a program or system using the technology. Respondents were allowed to select as many levels as they felt were appropriate.

Respondents were then asked to identify where they obtained or would plan to obtain competency in each technology. A list of training sources, including colleges and universities, technical colleges, seminars and conferences, vendor-sponsored training and self-study methods, was provided.

In the third section, printed on the fourth page of the survey, respondents were asked to identify barriers in the workplace which limited the use of instructional technology in training. In this section, respondents were provided with a list of potential barriers and were asked to indicate if the barriers were present in their work environment. These barriers included insufficient funding; hardware incompatibility; lack of management interest or support; lack of time, knowledge or technical skills among trainers; lack of interest among trainees; inadequate needs assessment; and lack of technical support. Respondents could also identify additional barriers if desired.

A cover letter was developed, printed and mailed with each survey. The cover letter explained the purpose of the study and the format of the questionnaire. It also emphasized the importance of respondent input and provided the name and complete address of the researcher. The cover letter also contained the informed consent information required by the researcher's university.

Data Collection

The 381 questionnaires were mailed with cover letters and postage-paid return envelopes on October 7, 1994. A pencil was included as incentive for individuals to respond to the survey. Seven of the surveys were returned to the sender due to an incorrect or outdated address. These individuals were removed from the sample, reducing the sample size to 374. Thirty percent of the sample, 112 individuals, returned the survey by November 5, 1994. On November 6, 1994, a second mailing, which included the questionnaire, a second cover letter, a postage-paid envelope, and a packet of instant coffee, was mailed to the remainder of the sample. By December 12, 1994, 49% of the sample, 184 individuals, had returned the survey. A phone follow-up was conducted between December 12 and December 16, 1994. An attempt was made to phone every individual who had not returned the survey. During the phone calls, individuals were asked several questions related to the use of instructional technology in training and reminded to send back the original survey.

As a result of the phone interviews, 54 additional people were removed from the sample because they were no longer employed at the organization listed in the directory. Thus, the final sample size was determined to be 320. Following the phone calls, another 15 surveys were returned. The final number of responses was 199, for a response rate of 62%. Of the 199 individuals who returned the survey, 52 individuals indicated that they were not involved in the design or delivery of employee training programs (mostly university faculty members, students and retirees) and did not complete all of the items on the survey. This left a total of 147 completed questionnaires to be analyzed.

Data Analysis

On December 23, 1994, the surveys were delivered to the University of Wisconsin-Stout's Academic Computer Center to be analyzed. The data were tabulated, and the surveys were returned to the researcher on February 3, 1995. In all sections of the survey, each item was analyzed in terms of frequency of each response and overall percentage for each option provided. In addition, Z-tests on the difference of proportions between the "yes" responses of current users and the "yes" responses of those who planned to use each technology were conducted to determine if there were significant differences between current and planned future usage. Chi-square tests were conducted to determine if there were significant differences between the various training sources selected by respondents.

Results

The results of the survey indicated that organizations are currently using a wide range of technologies, and there are 12 technologies that are currently being used by at least 50% of the respondents. These technologies include computer-based training, computer tutorials, computer simulations, computer presentation systems, presentation software, electronic performance support systems, on-line help systems, information databases, multimedia systems, LCD panels, LCD video/data projectors and local area networks.

These were the same technologies that 50% or more of the respondents indicated they plan to use in the next three years. However, respondents indicated that they plan to make significantly greater use of multimedia development and delivery tools including authoring programs, interactive video, CD-ROM, compact disk interactive and digital video interactive. They also indicate that they plan to use more complex technologies for their computer-based training and electronic performance support systems, including hypertext, expert systems, embedded/concurrent training, intelligent tutoring and virtual reality. There will also be greater use of computer conferencing to deliver training over distances.

According to respondents, there will be less use of certain types of distance learning systems, such as audioconferencing and one-way video. This would be logical as technology continues to evolve and provides more advanced, interactive systems for the delivery of distance education (Gery, 1994). There will also be a decrease in the use of computer presentation systems to deliver classroom training. This decline will occur as companies abandon classroom training for more effective and cost efficient electronic instruction delivered at the desktop (Galagan, 1994).

The levels of competency required to implement instructional technology in training programs were consistent across 27 of the 32 types of technologies included in the study. Overall, respondents reported that the ability to use or assist trainees in the use of the technology was the most highly needed competency. The ability to evaluate the effectiveness of a specific technology was also frequently identified. The ability to develop programs or systems was identified by few respondents as being necessary for most technologies.

Vendor-sponsored training and self-study methods proved to be the most popular choices for developing competency in instructional technology. Attending seminars, conferences or workshops was frequently identified for developing competency in some technologies; however, it was not the primary method for competency development in any specific technology. Significantly fewer individuals indicated that they would attend courses and programs at universities, four-year colleges or technical colleges to develop their skills in any of the areas included in the questionnaire.

The respondents indicated that a lack of time and a lack of financial resources are the major barriers in implementing instructional technology in training efforts, as these barriers were cited by approximately 75% of the respondents. Lack of compatibility between systems, lack of management support, lack of technical support and lack of trainer skills are barriers that were identified by more than 50% of the respondents. These findings were consistent with the literature on this topic, which indicates there are several reasons why technology has not been fully integrated into training programs, including high costs, lack of management support and lack of skills among trainers (Gery, 1994).

Conclusions

From the findings of this study, it can be concluded that the major types of instructional technologies used in training and development will not change dramatically over the next three years. However, there are several newer, more sophisticated technologies that will be used with greater frequency in the future. The respondents' current and planned uses of instructional technology are consistent with other recent studies on this topic that indicate there will be a greater use of interactive technologies that will change how, when, and where trainees learn (American Society for Training and Development, 1994). It is predicted that in the future more companies will utilize digital multimedia technologies and individualized performance support systems to provide flexible training opportunities to workers (Galagan, 1994).

From the survey responses, it can be concluded that it is far more important for trainers to be able to use and evaluate new technologies than to be able to design and develop their own programs or systems. The data from the survey support the concepts found in the literature in this area. Past studies on this topic have concluded that trainers should be familiar with the applications of instructional technology; however, program or system development is generally done by computer programmers or media specialists with expertise in these areas rather than by trainers themselves (Spitzer, 1988).

It was determined by the respondents that vendor-sponsored training and self-study methods are the primary sources of competency development in instructional technology. Seminars, conferences and other training programs sponsored by professional organizations appear to play a lesser role, and universities and technical colleges appear to play a minimal role in providing trainers with knowledge and skills in computer-based training, multimedia systems, EPSS, distance learning systems or computer presentation systems.

Finally, it can be concluded that a lack of time and a lack of financial resources are the major barriers to implementing instructional technology in training efforts. Lack of compatibility between systems, lack of management support, lack of technical support and lack of trainer skills are also significant barriers. However, there does not appear to be a lack of trainee interest in using instructional technologies or a general lack of support for training efforts.

Recommendations

This study was designed to assist training professionals, human resource development managers, academicians and others who offer training and degree programs by providing information on how instructional technology is currently being used in training and how it may be used in the future. These various groups may find the results of this study useful in future planning efforts.

Recommendations for Practitioners

It is recommended that training professionals and their managers use the data generated by this study in defining current and future training needs and in identifying resources to obtain new skills and competencies in instructional technology. In particular, training professionals should become familiar with the technologies that are currently being used by more than 50% of the respondents' organizations. Training professionals, whether working in small, mid-sized, or large organizations, should also become knowledgeable regarding digital technologies and other emerging technologies that large numbers of organizations plan to use in the future. Skills in using computer systems and electronic support systems have been formally recognized as essential competencies for training professionals (McLagan, 1989). The shift from face-to-face training to delivering information during the performance of work will require all trainers to become familiar with numerous delivery technologies (Galagan, 1994).

The data from this study suggest that training professionals should focus on developing competency in the use and evaluation of the various technologies included in the survey. However, in a small number of organizations, it is also required that trainers select and develop programs and systems. In addition to learning about hardware and software, comments from respondents and the literature indicate that trainers also should possess competencies in using traditional media technologies. Trainers should also understand the process of applying appropriate instructional technology to performance problems (Piskurich, 1993).

Recommendations for Training Providers

The results of this study may also assist faculty in colleges, universities and technical colleges; directors of professional organizations; hardware and software vendors and others who provide courses, programs and training in the field of instructional technology. The majority of respondents in this study preferred vendor-sponsored training and self-study methods to meet their instructional technology training needs. However, several respondents indicated that they and their colleagues have not been trained in many aspects of instructional technology and lack the knowledge or skills necessary to be effective in this area. Therefore, it is recommended that vendors and organizations that provide self-study materials expand their offerings in instructional technology training, particularly in the area of emerging technologies to help address this unmet training need.

Although several post-secondary institutions offer programs in instructional technology, few trainers seem to be taking advantage of these offerings. It is recommended that undergraduate and graduate programs in training and development and instructional technology review their instructional technology courses and competencies in light of the findings of this study to ensure that their courses are relevant and appropriate for training professionals.

Due to inadequate budgets for equipment and laboratories, it is often difficult for colleges and universities to stay current with technology (Lindstrom, 1994). However, if universities and technical colleges are truly interested in meeting the instructional technology training needs of training professionals, it is recommended that they form partnerships with vendors or professional associations to assist in offsetting the costs of providing hardware and software training on college campuses.

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Title:

Lifelong Learning for the 21st Century

Author:

Ron Goodnight

INTRODUCTION

A major United States automotive manufacturing company invested extensively developing a new computer-based, Computer Numerical Controlled (CNC) machining, robotics and high technology facility. The work environment and job content had changed, **BUT** the employees hadn't. They were totally unprepared for the new job requirements regardless of management's communications and worker involvement in organizing and equipping the facility. The employees were not fully competent to operate the equipment, activate and utilize the computers, analyze and diagnose problem causes or make timely repairs. Action was needed...immediately!

THE PLAN

A joint salaried and hourly employee task force formulated a plan to address both the immediate and long-term concerns. Their recommendation was to create an in-plant Lifelong Learning Center for the 21st Century to provide for personal renewal and technical updating of the workforce. Company and union leadership fully endorsed the plan and pledged their continued support. A training/education consultant was hired to assure needed confidentiality which seemed to be a real concern for the hourly employees.

COMMUNICATION

Five statewide schools and three consultant firms provided extensive communications about their respective personal renewal and work oriented programs. The workforce was informed via all-employee meetings, videotapes, written bulletins/announcements, live intra-plant video transmissions, in-plant computer inter-net systems, electronic bulletin boards and union membership meetings. Following this communications blitz, a learning needs assessment and interest questionnaire was developed, communicat-ed, and hand delivered in-plant to all 2,182 employees. The questionnaire was on the inter-net computer system, too, so its completion could be done and transmitted electronically. Each employee was offered a one-on-one confidential meeting if he/she desired. This was especially critical for those lacking reading and/or writing skills.

The 1,831 (84%) questionnaires completed showed 287 employees expressed interest in pursuing either a high school or college degree program. Basic work oriented remedial courses were requested by 179 employees and they all indicated a desire for specialized technical courses, too. A full range of basic through in-depth technical courses were selected by 388 employees while over 1,300 employees selected specific training programs such as interpersonal relations, conflict resolution, listening, problem solving, effective meetings, etcetera.

Follow-up information meetings were held concerning the (1)high school degree, (2) associates degree, (3) bachelors degree, and (4) masters degree programs. Those employees wanting work oriented remedial education were individually counseled and completed a computerized assessment. Help was provided to those needing assistance especially in the reading area.

Training program offerings were consolidated and prioritized according to technological and manufacturing needs. Those critical competencies for the new high-tech facility received top priority to satisfy the immediate needs. A master schedule was developed and employees needing the high technology and computer skills were trained immediately while the remainder of the workforce wanting this training were invited to sign-up for future offerings. A master sign-up time was announced for all the various training programs and courses and the employees responded beyond expectations.

THE BEGINNING

The personal renewal, technical updating Lifelong Learning Center for the 21st Century began and experienced immediate and significant success. During the first year, thirty-eight (38) employees took courses toward their high school degree or GED (General Equivalency Degree). Several of these courses of study were offered via television. Another 118 employees began pursuing various college degrees all within the facility. The teaching methodology utilized was many faceted: the normal teacher-student inter-action, the televised Indiana Higher Education Telecommunications System (IHETS) which broadcast courses from the statewide universities, computerized independent study and selected independent study coupled with mentoring. The college degree based students were about equally divided between associate degrees from Purdue University School of Technology or Indiana Vocational Technology

College, bachelor degrees from Ball State University School of Technology or Business School, and masters degrees from Ball State University or Purdue University in either executive development or engineering, respectively. All courses other than laboratory or experiential based courses were offered via IHETS, as available, and several courses used inter-active computer based courses for credit through Penn State University (International Correspondence Schools). Seventy-three (73) employees enrolled in work oriented remedial courses such as arithmetic, reading, writing, blueprint reading, measuring and metrics. Much of their training/education was via small group interaction facilitated by a professional instructor, interactive computer systems and video programs. Individualized help was readily available for those needing it. Over 400 employees completed technical oriented courses/programs such as computer applications, Computer Numerical Control (CNC) programming, CNC machine set-up and operation, basic and advanced electronics, mechanics and hydraulics/pneumatics concurrent with machine and robot troubleshooting, diagnosis and repair. Every conceivable method of training and education was utilized from computers, to laser discs, to simulation models, to IHETS etcetera. In addition to these first year accomplishments, over 1,000 employees participated in other training programs many of which utilized CBT, interactive computer systems and IHETS. The first year was a resounding success and the subsequent years have been equally as good. Goodnight - 3

Title:

The Use of Music in the Instructional Design of Multimedia

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The purpose of this study was to explore the way music operated in the mental processing of computer-supported instructional messages, whose other modes were text and graphics. The experiment examined the effect of music on the immediate recall and understanding of three equivalent science lessons delivered by a computer. The objective properties of the music were manipulated to produce feelings that were congruent with the psychological dynamics of the lessons' instructional strategies. This technique sought to enhance achievement by stimulating multiple (triple) encoding in short term memory. It aligned an abstract musical input, which elaborated subjectively on content, with instructional strategy, which is a subjective lesson element. This research, therefore, proposed and tested a variable, labeled MISI (Music-Instructional Strategy-Integration), that moderated the instructional treatments. The study also sought subjects' affective evaluations of the lessons accompanied by music as well as their preferences for music in association with academic endeavors.

The experimental procedure examined the effects on achievement of three forms of ninth grade lessons on physical science topics, each of which was differently moderated by music or ran in silence. This process involved repeated measures of subjects, taken at random from classes of ninth grade students. The investigation employed a Graeco-Latin Square, type GLSFF-3^3 design. This was a fractional factorial design, that evaluated two crossed treatments in the context of three groups of subjects.

The primary analysis of variance showed no significant statistical results regarding achievement. There was no statistically significant difference in the subjects ratings of the musical patterns, and no relationship between achievement scores and subjects' ratings was found. The subjects were consistent in favoring an association of music with academic activity.

This study found that the inclusion of music can stimulate positive student affect toward computer-supported instruction and toward science instruction. It identifies the need for additional research with multiple encoding, and with literal music, which depicts content by becoming one of its objective parts.

Computer-based multimedia is rapidly becoming an important instructional tool (Heinich, Molenda, & Russell, 1993; Schwier & Misanchuk, 1993). Research results document positive learning outcomes associated with the proper instructional use of this media format (Kozma, 1991). Interactive multimedia programs deliver instructional messages through a mix of text and graphics, still and motion images, voice, sound effects, and music. These complex messages are the means through which interactive multimedia presentations gain their considerable power to effectively communicate with learners (Heinich, Molenda, & Russell, 1993).

Little research exists on the use of music to enhance learning in the context of interactive multimedia. This void is not consistent with the universal recognition of music as one of the most powerful forms of human expression. Music is celebrated worldwide for its profound ability to create meaning (Abraham, 1980). Neither is this situation consistent with the steadily improving quality of digitized sound (McKell & McKell, 1994). Most of the research on the instructional use of music in older multimedia formats has concentrated on its affective influence (the feelings it induced) when the music was used as a background context for teaching. These research findings are mixed and inconclusive (McIntyre & Cowell, 1984; Ebisutani & others, 1991; Jaspers, 1991).

Music is regularly listed as one of the standard communication modes for constructing interactive multimedia presentations (e.g., Heinich, Molenda, & Russell, 1993), despite the absence of research-supported guidelines. When guidance is offered about how to insert music into this instructional format, it typically is general and highly subjective (e.g., Burger, 1993). Schwier and Misanchuk (1993) advise that music can be used to "augment" the presentation and to lend "positive emotional texture" (p. 268). The details of the process are left to the intuition of program designers and authors. One cause for this shortcoming is that a grounded, universally accepted understanding of the way music operates in the mental processing of multi-modal messages sent by a multimedia system has not been developed (Kellaris, Cox, & Cox, 1993).

Research has documented a positive impact on learning resulting from additive, dual encoding when linguistic inputs (text/speech) are combined with illustrations (Fleming & Levie, 1993). Rayburn and Tyson (1982) extended additive encoding to a third level when they concluded that music could compliment other images (linguistic and visual) and provide additional information to the brain in the form of auditory images. There has not, however, been any reported research into the use of triple encoding with music.

Hannafin and Hooper (1993) provide an excellent summary of the state of the art for constructing multi-modal messages. They maintain that:

> Learning via multi-modal instruction improves when there is sufficient conceptual and temporal overlap between the information presented in each modality (p. 196).

They anchor the above principle of learning in Paivio's (1971) finding concerning the effectiveness of dual encoding. Hannafin and Hooper state that dual encoding depends on the additive effect of encoding mechanisms in short-term memory.

The example given is that of combining text with illustrations, wherein the relevant encoding mechanisms are separate but complementary. The text is said to be a linguistic code form, which is normally (but not necessarily) scanned horizontally. To read text is a visual event, which means that it is a spacial phenomenon. Most people, however, employ a serial protocol in dealing with text. The encoding of illustrations is different. While it too is visual, and therefore also a spacial event, the illustrations are consumed in parallel. An image code form and another variety of encoder are involved in the latter case.

Hannafin and Hooper (1993) identify two conditions governing the effectiveness of multi-modal messages in learning. The first is that multi-modal messages should present information to students in code forms that are congruent. This is consistent with the findings of Kellaris, Cox, and Cox (1993) for persuasive messages in advertising and also with the findings of Boltz, Schulkind, and Kantra (1991) for schematic processing. The text and illustrations of Hannafin and Hooper's example must be redundant, focusing on the same teaching points. These authors warn that non-redundancy may interfere with additive encoding.

The second condition is a requirement that each presentation mode within these complex messages appeal to separate encoding mechanisms. To appeal to different encoders in the student's working memory, separate code forms (e.g., text and an illustration) must be used to enhance the formation of meaning. As a counter example, Hannafin and Hooper (1993) caution against an identical presentation of words via both text and speech.

Previous interference studies have shown that human beings are capable of using several different types of encoding mechanisms (Ashcraft, 1989; Leahey & Harris, 1985). Not only are there linguistic (text/speech) and image encoders, but there are sonic, olfactory, kinesiologic, and possibly other combined types of encoders.

It is unknown whether encoding mechanisms combine operations to achieve richer forms of encoding or whether they simply operate in parallel to achieve additive encoding. Although their pattern of operation is not yet clear, encoding mechanisms seem to exist in the limited capacity of short-term memory. Studies in Dual Task Analysis infer some limit to the positive effect of additive encoding (Ashcraft, 1989).

Schwier and Misanchuk (1993) conceive multi-modal instructional messages as consisting of core, supplemental, and peripheral elements. Music is usually inserted as a peripheral element in the mix (Kellaris, 1991), in part because no objective means of relating it to the other messages elements has been developed. Music therefore tends to be relegated to an opening, closing or background for the program. This conception and its inherent design convention seem short-sighted, and they preempt music's full potential to contribute to the presentation.

The nature and artistic tradition of music impedes its use as a tool of technology. Standard practice for dealing with music in education is much more subjective than objective. The educational use of music tends to be mainly intuitive for the following reasons. First, the power of music to create meaning is thought to operate primarily through emotional pathways (Schwier & Misanchuk, 1993; Burger, 1993). Second, music appreciation has typically been approached historically and/or stylistically, in terms of extant compositions. Finally, the objective use of music requires some facility with theory, which is complex and difficult. Music has a special vocabulary and mathematical precision.

The problem with this appropriation of music is that it fosters an incomplete and unscientific approach. It suggests a use of music that is based only on musical genres (e.g., a march versus a dirge) and only by association (e.g., the deep "Dum ... Ba-Dum" from the movie, JAWS, suggests extreme, unseen jeopardy).

This tendency to appropriate music only on the basis of intuition obscures a more technological approach to its use. Music can be selected and inserted into instructional programs more precisely if that insertion is based on its objective properties. There is empirical evidence that music can be manipulated, using its objective properties like tempo, tonality, and texture to produce psychological feelings such as arousal, surprise, and pleasantness (Kellaris & Kent, 1993). Instructional designers, while paying some attention in the past to tempo (e.g., Wakschlag, Dietz, & Zillman, 1982), do not yet take full advantage of this way of applying music to their programs.

Previous reviews of the literature have been narrowly focused. Research is being conducted across a number of disciplines that are important in understanding the effects of music within instructional environments. Also, much of the existing literature is contradictory. Numerous studies have used music as a variable. The most recent studies are finally focusing on distinct properties of music.

Review of the Literature

This analysis of the literature did not locate any reports of research into the use of music as an instructional message element in the context of interactive multimedia. Some textbooks mention this application of music (e.g., Schwier & Misanchuk, 1993), but their coverage is limited.

There is, however, a substantial amount of literature about the use of music in teaching with other media. Most of this material exists either in the form of programmatic essays in magazines and journals or as research reports. The program guides start with the assumption that music can enhance learning. They generally endorse the use of music in education, describe its application in a particular instructional situation, and disclose positive affective responses by students.

The research literature reports mixed findings about the effects of music on instruction. Dr. Dolf Zillman (1994), a noted scholar in the field of communications, interprets the consensus of the literature as follows:

> The evidence concerning the use of music in educational efforts is most discouraging. Surely, as we have shown, music can help to attract children to the educational message (in selected situations). But once they are exposed, the presence of music is detrimental to learning. That's what the experimental research tells us. The findings are very consistent, showing that it is sweet illusion for educators to think that music could further the learning process. Music is a message that **competes** with educational information for attention, and it usually wins the contest.

There is, however, a minority body of evidence together with an even greater amount of teacher intuition that opposes Dr. Zillman's judgment. This subset of the literature supports the counter argument that music can enhance the presentation of educational information.

Such differences of opinion can only mean that a full understanding of the dynamic interaction between music and instruction has not yet been achieved. That conclusion constitutes the need for further study.

Musical Acuity / Intelligence / Academic Achievement

The general connection between musical acuity and intelligence or academic achievement has been the focus of a number of studies. Cary's (1987) review of the pertinent research indicated a definite connection between the exposure of children to music and higher levels of intelligence. This applied also to cognitive skills such as problem solving, risk taking, and creativity. Dryden (1992) demonstrated this linkage in fifth grade students. She documented a positive correlation between students' instruction in music and the development of verbal skills. Hilliard (1993) amassed five case studies profiling the characteristics of creative adolescents. All loved music.

A connection between music and academics has been identified. The exact nature of the relationship has not, however, been determined.

Musical Expression

The expressive power of music has been known since ancient times. Martin Luther, for example, had the highest praise for music. Luther ranked it second only to theology in his hierarchy of God's gifts (Randal, 1986). Other teachers, through the ages, have used music in various ways to make students more - and sometimes less - receptive to learning.

How music operates to express meaning remains a major concern of aesthetic criticism. Expressionists base their understanding in the composer's intentions when creating a work or in the appreciator's feelings when consuming the work. Formalists argue that musical expression derives from the listener's cognitive recognition of the musical elements of the composition melding into a whole. Moderate perspectives urge a synthesis of these affective and rational responses (Behrend, 1989).

Burger (1993) provides guidance for designers about the use of music in multimedia. He categorizes music as literal or abstract. Literal music depicts content by becoming one of its objective parts, i.e., a sound effect such as birds chirping or water rushing. Abstract music elaborates subjectively on content. It operates as a communications device, using emotions (e.g., sadness, love, joy, patriotism, etc.) to embellish the content. Literal music operates on or off screen, conveying proximity or environment. Abstract music operates off screen, stimulating mood and a sense of time, geographic location, association, signature and continuity, and memorability. Burger also introduces elements - melody, harmony, rhythm, instrumentation, musical genres, time signature, tempo, structure, and silence - that can be used to convey meaning. He states that these devices "can imply much more than what is being said and/or portrayed visually" (p. 334).

The scholarly concern with such aesthetic expression extends back to the 1800's (e.g., Gurney, 1880; Gundlach, 1935; Rigg, 1937; Watson, 1942; Holbrook & Bertges, 1981). Gurney explained this expressive power of music as early as 1880 in the following way:

> {T}he power of music to suggest external objects and events and intellectual conceptions ... may take place in two ways. First, the actual sounds and motions of the music may perceptibly resemble actual sounds and motion of other things ... The second way in which images of external facts may be suggested by music is by general qualities ... {T}he same calm and steady musical flow which might suggest a quiet succession of waves has naturally an expression of tranquillity {sic} corresponding to the same idea (p. 349-50).

A good example of classical music's ability to produce sound effects is found in Grofe's Grand Canyon Suite. One hears in this work a credible musical image of a donkey's "clopping" along a canyon trail and also a vivid representation of a thunder storm. There are similar musical dynamics in Prokofiev's Peter and the Wolf and in Saint Saens' Carnival of the Animals.

Good examples of classical music's power to express the content's general qualities are Wagner's Tristan und Isolde of love and passion; Smetana's Ma Vlast of patriotism; Holst's The Planets (Mars) of militarism; Berlioz's Requiem (2nd Movement - Dies Irae) of fear; Stravinsky's Rite of Spring of sexuality; Mahler's Resurrection Symphony of transcendence; Beethoven's Ninth Symphony of joy; Verdi's Stabat Mater of lament, etc. Other types of music are equally capable of such expression.

Human Response

Humans respond both physically and mentally to music. The physical response has been documented in studies of efforts to combat text anxiety. Such efforts have produced mixed results. These experiments usually measure and report the impact which music can have on pulse rate, blood pressure, skin chemistry, etc. (e.g., Blanchard, 1979; Moseley, 1990).

How humans respond mentally to the stimulus properties of music is varied and complex. There are both affective and cognitive responses to music, which are conditioned by individual differences (Rayburn & Tyson, 1982). Irish (1993) found that when adults have free choice of words to respond to music, their affective and cognitive responses are personal and idiosyncratic. There were, however, consistent patterns of response in and between individuals with similar education and experience. Personality traits also affect reactions to music (Lewis, 1991).

Paris's (1993) recent study is but one example of the powerful impact of music in the affective domain. She found significant results when assessing the effects on fifth graders of stimulating music as compared to sedative music. Such effects can be time sensitive. Brentar an associates (1994) found an inverted U-shaped relationship between frequency of exposure to rock and popular songs and the affective response of undergraduates toward the songs.

The traditional view has favored an affective response (feelings, emotions) over a cognitive response (empirical factual knowledge processing and problem solving) to music (e.g., Schwier & Misanchuk, 1993). Hylnka (1980), writing about the favorable implications of general film music for television and other instructional films, drew the conclusion that only affective learning is influenced by music. Recognizing the difficulty of dealing experimentally with aesthetics, Price (1986) proposed a precise, professional vocabulary on affective responses in the field of music.

There is evidence of music's ability to affect cognitive processes. Bickel (1992) presented a means of investigating the cognitive component of music listeners' responses through analysis of their verbal reports. She found that seventh and eighth graders often presented creative metaphors, described unique perspectives on the listening experience, displayed personal idiosyncrasies, found overall unifiers, and invented unique listening tools.

The most publicized, contemporary work on the impact of music directly on cognitive operations is that of Frances Rauscher (1993). She reported finding, in two, similar experiments with different audiences, that exposure to music enhances specific spatial reasoning skills, without necessarily invoking emotions.

Dr. Rauscher's musical treatment (Mozart - a sonata for pianos) was administered to the sample prior to the reasoning task, not concomitantly with it. Her data showed that this musical score acted, physiologically, to prime the same neural net that was involved in the problem solving exercise. She found also that this beneficial effect of music was not permanent. It dissipated within fifteen minutes.

Other information concerning music and the brain is contained in a database (Music and Brain), which is accessible over the Internet. This database offers references to scholarly articles, books, conference proceedings, theses, reprints on music history, education, psychology, and the physiology of hearing and making music.

There is evidence that students, whose mental operations favor the right hemisphere of the brain, are more appreciative of music. Zalanawski (1990) analyzed this tendency. She reported results from a mixed sample of undergraduates, who responded both verbally and visually to a musical selection. Those with a right brain orientation showed greater appreciation as measured by attention, understanding, and enjoyment scores.

It is, however, an oversimplification to portray aesthetic appreciation and creativity solely in the right hemisphere and rationality only on the left side. Levy, as early as 1983, concluded that:

> The two hemispheres differ in their perceptual roles, but both sides are involved in the creation and appreciation of art and music. Both hemispheres are involved in thinking, logic, and reasoning. The right hemisphere seems to play a special role in emotion, e.g., humor. If students are emotionally engaged, both sides of the brain will participate in the educational process regardless of the subject matter. (p. 68).

There is additional support for the notion that both hemispheres of the brain are engaged by music (MacKinnon, 1981; Merrion, 1988; Piro, 1989).

There has been consideration of the connection between music and thinking. Marek (1993), using music to induce moods, found no significant effect on memory. Stratton and Zalanowski (1985) got mixed results when they tested paired associate memory with imagery and repetition instructions with and without background music.

Instructional Uses

Studies concerned with the effect of music on student achievement have typically examined specific settings, student populations, and/or subject matter. These often overlap. These studies have generally assessed student behavior when different types of music were presented to students during instruction. The range of types of music used with instruction has been very wide. It includes rock, classical, easy-listening, and has even been extended to rap (Anderson, 1993).

Setting

Teachers have long been concerned with the creation of a setting conducive to learning. A holistic approach to teaching means appealing simultaneously to the student's physical, emotional, and cognitive domains. The relatively recent discoveries about brain functioning have encouraged this approach.

A program of this type is Lozanov's "Suggestive Accelerated Learning Technique" (SALT). To foster holistic learning, SALT uses music only as a general context. The music is selected by genres and applied as sonic mass (Kellaris, Cox, & Cox, 1993) simply to envelop the instruction. Its purpose is to set a mood, induce relaxation, and to be broadly suggestive. The hope is that music will operate as a catalyst for learning because it increases receptivity in the brain.

SALT gained a substantial following and has been the subject of considerable experimentation (Schuster & Gritton, 1986). There is a sizable body of literature pertaining to this method, much of which deals with music. The pertinent experimental results with SALT, however, are mixed and inconclusive. For example, Cullen (1986) reports significant gains from the use of accelerated learning in language instruction. Conversely, Confer-Owens (1992) found that SALT made no difference in teaching study skills to under-prepared college freshmen. Moon (1985) used a meta-analysis to show that relaxation techniques had only a small positive effect on cognitive academic variables.

There are other studies of music as a favorable context for academic productivity. A typical example is Kellogg's (1982) finding that many successful technical writers regularly work with background music. He surveyed one hundred twenty seven engineering professors about their academic productivity and writing habits. Multiple regression analysis revealed that background music was among the tools used. While this study does not deal with instruction, it may have implications for the use of music in non-traditional learning environments.

Student Type

Studies have been done with specific populations of learners. The major groupings have been of regular students versus those with special needs. Regular students have been further subdivided according to age/grade level (e.g., Davidson & Powell, 1986); by sex and perceptual type (e.g., Rayburn & Tyson, 1982); and by geography (e.g., Eaton, 1985; Talabi, 1986; Hicks, 1987).

A typical experiment with normal students was run by Davidson and Powell (1986). They observed twenty six students in the fifth grade over a four month period to determine the effect of easy-listening background music on on-task-performance (O-T-P). Time series analysis indicated a significant increase in O-T-P for male subjects and for the total class.

Music has been used in a wide variety of special education situations. The relevant literature is a blend of programmatic guides and reports of experiments. The former are generally favorable while the latter report mixed experimental results. Studies done with this population typically used a background music treatment and measured variables such as stress levels, hyper-activity, anxiety, psychomotor skills, and cognitive achievement.

An example of one such study was reported by Kleckley (1989). He used two different populations, learning disabled high school students and secondary remedial students. The study involved a three week unit on the Constitution which was followed by four parallel quizzes. Background music was provided during alternate testing sessions. Kleckley found significant variations for the learning disabled group in the form of lower stress levels and higher test scores with background music.

Subject

Studies using music during instruction have been done with a wide range of subject matter, again with mixed results. Music has been widely used in teaching language. Studies have also included: mathematics, spelling, writing, vocabulary, reading, social studies, history, and multicultural education. This group of studies have generally measured achievement and/or affect.

There are more references to the use of music in teaching language than any other subject. Several experiments connect music to verbal learning. Peters (1993) observed that music seemed to encourage verbal auditory learning among second graders. Pietrick (1988) found no significant changes in attitudes of sixth graders regarding the effects of music and art in remedial language arts development.

Music has been used in teaching several science subjects. Beauchamp (1989) included a musical factor in his comparison of the effects of slide plus tape presentations in biology. He found significant differences among four treatment groups in the degree of affective response and cognitive achievement. Among his conclusions was that music - more so than visuals - prompted long range positive affective responses.

Smith and Davidson (1991) reported a study of the effects of music listening on student achievement. The subjects were seventh-graders, who were independently learning astronomy. There were no significant achievement differences among students who learned while listening to rock, classical, easy-listening, or no music at all.

Literature Reviews Within Education

There have been a number of literature reviews regarding the use of music for instructional purposes since 1984. Two of these pertain to particular groups, which are exceptional and at-risk students. A third is more general. All of these reviews conclude that the research results which they considered are mixed and inconclusive. Each cites the need for further investigation.

McIntyre and Cowell (1984) reviewed the research concerning the effects of music on academic performance and behaviors of exceptional students. They found that such studies pertained primarily to achievement in mathematics, reading, and the ability to attend to study materials. McIntyre and Cowell also discovered that the research concerning behaviors of exceptional students concentrated on task-related behavior, unacceptable behavior, interpersonal conflicts, motor activity rate, relaxation, and attention span. They concluded that the findings regarding the effects of music on studying, mathematics, reading performance, activity rate, and social behavior are unclear and often contradictory. They call for more research in this area.

A second literature review, performed by Ebisutani and associates (1991), focused on at-risk students. These reviewers considered the effect of music on the reading, oral language, and writing abilities of marginal students. The intention of the analysis was to identify and describe how music should be used in classrooms to facilitate language development. Ebisutani et al. considered three types of publications, theoretical works, research reports, and essays of practical classroom applications. They drew two conclusions. First, they decided that the research results were mixed and inconclusive. The evidence did not suggest to them that music has the potential for producing a positive effect on reading rate and writing fluency. Second, they found that the theories used to justify the use of music in reading and language arts activities are not firmly grounded in any research. Accordingly, these investigators joined in the call for further study, pressing for examination of the critical variables involved in music's effects on the literary development of students.

A review of the literature performed by Jaspers (1991) deals with music as a component of instructional materials. Observing the scarcity of literature on the use of music in audiovisual productions and its implications for their design, this review concentrates on the relationship between music and emotion. It also links music and cognition, but to a lesser extent.

Jaspers' (1991) study considered music to be a form of nonverbal communication (cf. Hylnka, 1980). His review discusses the learning outcomes of music in the affective and cognitive domains, including its emotional and structural aspects. Jaspers concludes that:

> {T}here appears to be no absolute need for music as a component in an instructional programme. Music is, however, one out of a set of effective means to evoke a desired emotional state in the viewer/listener, or to comment on information conveyed, or to line out certain aspects of the structure of the problem (p. 51).

He goes on to suggest that:

> by manipulating musical variables such as tempo, modality, {and} rhythm, the designer of the audio-visual programme may try to reach more emotional ends, and by manipulating the easy to recognize musical elements such as melody and instrumentation, he can manipulate the more cognitive and structural ends (p. 51).

No evidence has been found that indicates experimentation by Jaspers to test this conclusion.

Other Europeans are reported to be studying the educational use of music including Brosius of the University of Mainz in Germany and Broeckmann at the University of Klagenfurt in Austria (Zillman, 1994). In a German article addressing the musical dimension of education, Dietrich and Wermelskirchen (1990) explore how musical events educate by examining the debate between emotional and cognitive responses to music.

The evidence and opinion to date, concerning the use of music to enhance educational efforts can only be seen as inconclusive and discouraging. The presence of music is thought by some to be non-essential in instructional programs, as was concluded by Jaspers. Others are even more critical, pointing out that some applications of music can be disruptive, (e.g., Hannafin & Hooper, 1993). Such interpretations are based on the well documented distraction effect of music. These studies begin with Fendrick's work (1937) and continue until recently, (e.g., Zuk & Danner, 1986).

The studies reported on to this point, have one thing in common. They have generally used music only as background, comparing instructional treatments with background music to instructional treatments without music. The only way that some studies attempted to manipulate the music was by the type of music, thereby altering the tempo, rhythm, and/or harmony which can alter moods or affective responses. One additional variation to the use of music in these instructional studies has been where background music has accompanied test-taking.

Interdisciplinary Studies

Research on the use of music to enhance instruction continues. Significant work is also being done outside the discipline of education. The relationship of music to various settings, audience categories and behaviors, and varieties of subject matter is still being studied. There is a new concern, however, with the mechanics of communication, cognition, and the objective properties of music. Hylnka (1980) suggested a theoretical basis and some practical guidelines for using music in multimedia productions, based on a critical review of the behavioral research on film music. His theoretical perspective was non-verbal and multiple channel communication.

Seidman (1981) studied the role of music in motion pictures to suggest ways that educators might use music to improve the effectiveness of their instructional films. Seidman reviewed several studies showing that tempo, modality, rhythm, and harmony interact with audience characteristics to alter moods and thus shape their response to presentations. Seidman was not optimistic that musical accompaniment to media productions would improve student performance on achievement tests or enhance learning and retention of cognitive content. He did, however, suggest that both affective and cognitive interpretations of these productions are influenced by such "sonic scenery" which the musical score creates (p. 51).

Rayburn and Tyson (1982) investigated the effect of background music with lecture tapes, filmstrips, and films in teaching freshman psychology concepts. They compared media, visual or non-visual (haptic), and male and female learners. Treatment conditions included music during presentation, during both presentation and testing, or no music. The administration of the treatments - three music conditions crossed with three media types in the context of three groups, constituted a Graeco-Latin Square, type GLSFF 3 design. Results using difference scores by sex showed no effect except when film was the medium of instruction. Film was a better medium of instruction for women. Results using difference scores by perceptual type showed no effect except when lecture tape was the medium of instruction. With the music at presentation condition, visuals improved but haptics did not. Both visuals and non-visuals improved more when background music was present not only during the instruction but continued during the test. Rayburn and Tyson drew the conclusion that, "music may serve as an auditory image, which provides additional information to the brain just as Paivio's visual images seem to do" (p. 21).

Rayburn and Tyson's (1982) hypotheses were rooted in the distraction effect of music and in the widely held assumption that males are more visual than females. They predicted that when music was added to media presentations with both visual and verbal elements, the visually oriented subjects, i.e., males, would score lower. Conversely, the haptically oriented subjects, i.e., females, were expected to score higher. They also anticipated that the same background music added to a lecture presentation would lower the scores of the visuals and would not affect the scores of the haptics. These hypotheses were not supported by the data. The test scores of both visuals and haptics improved when the music was continued through the test. The insertion of the music in this research was imprecise (only background music was used). Also, neither the media type nor the lesson content were equivalent which are necessary when using their chosen research design.

Wakshlag, Reitz, and Zillman (1982) manipulated the tempo of music in an educational television program to study its impact on attention gaining and information acquisition. Their findings offer a mixed endorsement of music. What is of importance is their experimental technique of manipulating the musical input according to one of its objective properties. Later, Reitz (1984) found that background music's major value as an attentional device in educational television appears to be its ability to bring viewers back to the screen once their gaze has drifted away.

Boltz, Schulkind, & Kantra (1991) assessed the effects of background music on the remembering of filmed events in order to better understand schematic processing, a cognitive process. They employed a factorial design, in which sixty students in an introductory psychology course were randomly assigned to two groups. The subjects were presented with a series of filmed episodes in which the mood of the background music was either congruent or incongruent with the episode's outcome. For one group, the music always foreshadowed the ending of an episode. For the other, the music always accompanied the final outcome. A control group saw the same filmed episodes with no music. They found that recall was significantly enhanced when the mood of accompanying music was congruent with the mood of the scene's outcome. They also found that mood-incongruent music was more effective (memorable) for the foreshadowing treatment. Data from a cued-recognition task showed that music could provide effective retrieval cues for recognizing the scene it had originally accompanied. In addition, music with positive affect consistently produced higher levels of performance than did negative ones.

Kellaris (1991), Kellaris, Cox and Cox (1993), and Kellaris and Kent (1993) have conducted a multi-dimensional investigation into the effect of background music on ad processing. Kellaris (1991) and Kellaris, Cox and Cox (1993), proposed and tested a contingency variable, entitled "Music-Message-Congruency." This construct refers to, "the congruency of meanings communicated non-verbally by music and verbally by the ad copy". The experimental results indicate that, "increasing audience attention to music enhances message reception when the music evokes message-congruent versus incongruent thoughts" (Kellaris, Cox & Cox, 1993, p.51).

Kellaris and Kent (1993) performed an exploratory investigation of responses elicited by music varying in tempo, tonality, and texture. Three dimensions of human feelings - arousal, surprise, and pleasantness - emerged from the responses measured. They reported their findings as follows:

> Pleasure was influenced by the interactions of both tempo and tonality with texture. Faster speeds and more consonant keys increased the pleasantness of classical, but not Pop, music. Arousal was influenced by the interaction of tempo with texture. Faster speeds produced greater arousal among subjects exposed to Pop, but not classical, music. Feelings of surprise were influenced by tonality such that less consonant keys, i.e., atonal relative to minor, minor relative to major, were rated more surprising.

The stimulus property of music to create the feeling of arousal also has advocates as an accelerated learning technique with hyperactive and disabled students (Applegate & Hamm, 1985; Windwer, 1981).

Analysis of the literature confirms the suspicion that there is as yet no grounded, universally accepted understanding of the way music operates in the mental processing of multi-modal instructional messages. Furthermore, there is little evidence of new research into the issue as it regards interactive multimedia instruction. Past evidence about the impact of music on learning, in any format, is inadequate and inconclusive. The older research findings are certainly mixed. Consequently, many interpret the data in an entirely negative way. They underscore the powerful distracting properties of music, and they favor a minimal use of music in educational programs.

The practical advice which is often given to designers concerning the use of music in their instructional products is meager. It sometimes carries a warning that the wrong kind of music can sabotage the lesson. The best practical advice about the most effective use of music seems to exist in the discipline of advertising.

The human response to the stimulus properties of music is complex and difficult to understand. That process continues to be the source of debate about the balance of affective versus cognitive operations.

The question about a more effective use of music in educational communications continues to be asked and the body of literature on the issue is growing. Research is being conducted internationally and in academic disciplines beyond education, e.g., psychology (brain research), communications (film studies), and in advertising. Among the growing number of reports about positive effects of music on learning, cognition, or affective response, are at least nine works (Hylnka, 1980; Seidman, 1981; Wakshlag, Reitz, & Zillman, 1982; Reitz, 1984; Kellaris, 1991; Boltz, Schulkind, & Kantra, 1991; Jaspers, 1991; Kellaris, Cox, & Cox, 1993; Kellaris & Kent, 1993). Such work is launching a new trend in the way music is applied in instructional design. Each of these works involves inserting music into the instruction or message according to its objective properties.

Studies are beginning to deal with the integration of music into the mechanics of communications messages. This technique breaks with the past practice of using background music throughout the lesson and expecting it to function as a contextual catalyst for learning. It is, therefore, becoming popular to use elements of music in experiments as moderating variables, which embellish the treatment variables. This practice has shown some positive results (Kellaris, Cox, & Cox, 1993).

The present study was designed to assess a procedure for integrating music into multimedia instruction to enhance learning. This procedure had three components. First, it employed multi-modal messages, which attempted to foster triple encoding in short term memory. These multi-modal messages were constructed of three congruent code forms. Text, illustrations, and music were the codes that were used because each is processed in a different encoder in short term memory. Second, the procedure managed the musical input using the objective properties of music. Third, the procedure linked the musical input to instructional strategy as the means of achieving redundancy among the code forms.

This research proposed and tested a variable, labeled Music-Instructional Strategy-Integration (MISI), that moderated the instructional treatments. The study anticipated that the beneficial impact of music in multimedia instruction is directly related to the extent that the music enhances psychological operation of the lessons' instructional strategies.

The intention of MISI was to systematically leverage music's ability to elicit feelings of arousal, surprise, and pleasantness through manipulation of its objective properties of tempo, tonality, and texture (Kellaris & Kent, 1993). MISI linked this ability of music to two standard instructional strategies that evoke these same feelings. The operational strategies were affective orientation and cognitive dissonance. The first involves arousal, and the second entails surprise and pleasantness when the dissonance is reconciled (Hannafin & Hooper, 1993). These two strategies guided construction of the text and graphics portions of the treatment lessons.

Three physical science lessons were designed for delivery by a multimedia computer. Two patterns of music were produced for each lesson. The first pattern caused the affective impact of the musical selections to be congruent with the psychological dynamics of the instructional strategies. This arrangement was intended to moderate the treatment to enhance achievement. The second pattern caused the affective impact of the musical selections to be incongruent with the psychological dynamics of the instructional strategies. Conversely, this arrangement was intended to moderate the treatment to retard achievement. Each lesson was also delivered with no music or silence.

Method

Subjects

Subjects were 48 ninth grade students from a high school in a middle-class socioeconomic metropolitan area. They were enrolled in a physical science class that used very little multimedia. All of the subjects were on a regular academic track.

Materials

A single multimedia computer was used to present the treatment lessons. An audio tape player, with detachable speakers was also used. The computer, monitor, and speakers were situated either near the end of a large conference room table or on a classroom counter for comfortable subject access (seated) to the presentations. This equipment performed flawlessly throughout the experiment. All settings were void of major distractions.

Three lessons on physical science topics, designed especially for this investigation were installed on the computer. One lesson was about energy, another was about machines, and the third concerned physical forces. They concentrated on comparing the contrasting types of energy, machines, and physical forces and on measurement within each of the categories.

The lessons were designed using the instructional strategies of affective orientation and cognitive dissonance. This was accomplished under the direct guidance of the teacher who hosted the final phase of the experiment. She is a practicing classroom teacher, who regularly presents these topics to her ninth grade class. Every effort was made to structure the lessons to be equivalent in form and rigor. The lessons were also formatively evaluated by several of the teachers whose students participated in the pilot studies.

The visual elements of the lesson presentations were developed using PowerPoint (Microsoft, 1992). Each lesson was cast in its own, unique screen design to distinguish it and to combat student boredom. The base screen design ("wizard") for each lesson was chosen for its clean, uncluttered appearance, vivid colors, and contrast. The lessons were presented in the "slide show" mode. Each lesson ran for approximately 7.5 minutes. The transition between screens was a standard, quick cut through black. The parts of the lessons were divided roughly into thirds. The first one-third of the screens accomplished affective orientation. The second third established dissonance by lifting up discrepant events. The remaining screens provided reconciliation by explaining away the dissonance.

All screens contained two main visual elements, which were text and still graphics. The graphics were obtained from PowerPoint's (Microsoft, 1992) clip art file. The words appeared on the left side of the screens, and the graphics were on the right. Screens were timed on the basis of the number of words they contained. Short messages of up to four words appeared for seconds. The time for longer messages was extended for one second per additional two words. All of the subjects, during the pilot studies, reported having enough time to read all screens. A major effort was made to reduce formal language.

Two sets of the lessons were accompanied alternately by music. The third set ran in silence. The musical accompaniment was simulated using the audio tape player rather than internal to the software. This was done to achieve control and precision. The use of an audio tape player provided a sure control for coordination of the musical passages with the set of screens it was intended to support. It also allowed the addition of a production value. Through the use of the volume control, the music was faded in and out at the transition between sets of screens. The music was played at the #2 volume setting as was recommended during the pilot studies. A suggestion was also made during the pilot studies that the audio tape player not be readily visible for fear of calling attention to the music and its manipulation. This recommendation was followed, and the player was relocated in the final phase of the experiment to be less noticeable.

The music accompanying each of the lessons was unique and tailored to that lesson. Each sound track contained three strains of classical music, based on the advice of experts in the field. Classical music was used throughout for uniformity and because of its unfamiliarity to the subjects. Classical music is highly ordered, and its use added an extra dimension of control to this moderating variable.

Table 2 presents the works from which the music accompanying each of the lesson parts were drawn. The full titles of the recordings are in Appendix A.

Table 2

Musical Selections by Lesson

Lesson	Congruent	Incongruent
Energy	Beethoven-Egmont Berg-Chamber Music Elgar-P&C March #4	Gorecki-Sym.#3 Bach-Sinfonia Albinoni-Adagio
Forces	Beethoven-Fidelio Berg-Concerto Tchaikovsky-March Slav	Holst-Venus Elgar-Nimrod Albinoni-Adagio

Machines	Rossini-Barber of Sev.	Vivaldi-Largo
	Berg-Chamber Music	Bach-Air
	Holst-Jupiter	Marcello-Adagio

Experimental Design

This study used repeated measures of subjects' immediate recall and understanding of lesson content together with their effectiveness rating of the lessons supported by music. A Graeco-Latin Square, type GLSFF 3^3 design (Kirk, 1982) was employed to obtain repeated measures. This is a fractional factorial design, evaluating varieties of two crossed treatments (visual lesson presentations and music) on individuals drawn at random from classes and separated into three groups. This design is best represented by a cube with 27 cells. Only three of the cells on each of the levels contained scores. Each cell containing scores occupies a unique position within the cube in terms of rows and columns.

The treatment effects are both between and within subjects. The design assumes that the fixed effects are the treatments and that the blocks are random effects. It also assumes no interaction effects.

Dependent Measures

There were three types of dependent measures in this study. These measures included a posttest performance for each lesson, a subjective evaluation (rating) of the interaction of music in each lesson, and a survey of student preferences.

Subjects were given a paper and pencil test on lesson content immediately following each presentation. The first part of the test contained 16 true/false, multiple choice, and fill-in-the-blank types of questions. The order of the questions was arranged so that their sequence did not parallel the lesson presentation. The alpha coefficients for the tests used in the study were as follows: Energy test = .70; Physical Forces test = .66; and Machines test = .68.

Each test also contained a second section where the subjects subjectively evaluated the interaction of the music and the lesson. The subjects were asked to indicate whether they felt that the music, when present, made the content of the lessons more or less understandable. A rating scale with a range of 1 (less) to 10 (more) was provided.

Following the last quiz, the subjects were asked to complete a survey. It measured subjects' preferences for music by type, music's presence in their academic pursuits, multimedia science lessons, and favorite type of science class.

Procedure

Several pilot studies were run in preparation for the formal experiment. Pilot studies were conducted at five sites during the spring and early fall to formatively evaluate the components of the experiment. Two of the pilot studies involved a full administration of the experiment. Three others had special purposes involving equating the lessons and achievement tests together with ensuring the reliability of the instruments.

The final, formal phase of the experiment required 3 days to administer. Little discussion was needed with subjects in order to initiate the experiment. They simply were told that they would view three science lessons and would take a quiz following each. To enhance their motivation, the subjects were told by their teacher that their scores on the tests would constitute a daily grade.

A random selection of the beginning cell yielded the machines lesson moderated by incongruent music. With this starting point located, the GLSFF 3^3 design mandated the following order of treatment administrations to the respective groups. The treatments for Group One were the machines lesson with incongruent music, forces with no music, and energy with congruent music. Group Two received the lessons in the order of forces with congruent music, energy with incongruent music, and machines with no music. The scenario for the third group was the energy lesson with no music, machines with congruent music, and forces with incongruent music. This scenario is shown in Figure 1.

Figure 1. Administration of the treatments

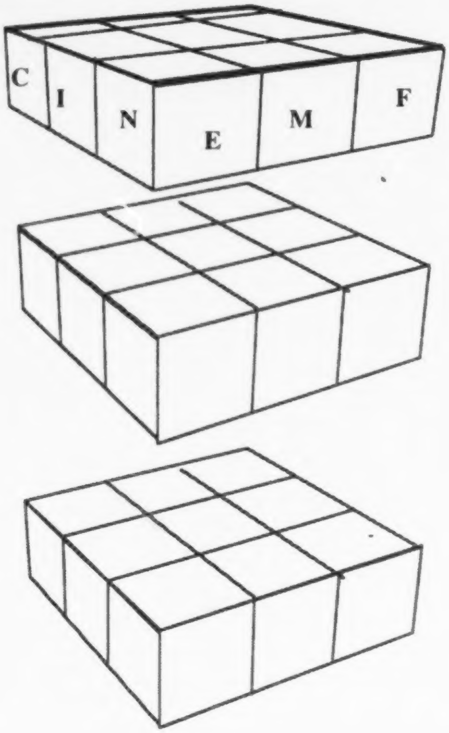

Figure 1. Viewed from top to bottom, the shaded cells contain scores for Groups 1, 2, and 3. The lessons are shown on the right face of the cube (E = energy, M = machines, F = physical force). The musical patterns are shown on the left face of the cube (C = congruent, I = incongruent, N = no music).

Results

Posttest Performance

The summary tables which follow organize the data for use in the analysis of variance required by the GLSFF 3^3 design. Table 3 presents, by group, the number of test items answered correctly in relationship to the lessons.

Table 3

Group Scores by Lesson

Group	Machines	Forces	Energy	Total
1	150	135	146	431
2	148	149	165	462
3	152	146	165	463
Total	450	430	476	

Table 4 presents, by musical pattern, the number of test items answered correctly during each administration of the treatments. It profiles the effect of the musical patterns across the sequence of treatments.

Table 4

Group Scores by Musical Pattern

Pattern	Treatment 1	Treatment 2	Treatment 3	Total
Incongruent	150	165	146	461
Congruent	149	152	146	447
No Music	165	135	148	448
Total	464	452	440	

Table 5 presents group performance in the context of all treatment components, where:

a_i = lesson; $_i = 0$, machines;

$= 1$, forces;

$= 2$, energy;

b_i = group; $_i = 0$, group 1;

$= 1$, group 2;

$= 2$, group 3;

c_i = music; $_i = 0$, incongruent;

$= 1$, no music;

$= 2$, congruent;

Table 5

Total Number of Items Correct in Each Treatment Component

$a_0b_0c_0$	$a_1b_1c_2$	$a_2b_2c_1$
150	135	146
$a_1b_0c_1$	$a_2b_1c_0$	$a_0b_2c_2$
149	165	148
$a_2b_0c_2$	$a_0b_1c_1$	$a_1b_2c_0$
165	152	146

Tables 6, 7, and 8 contain, by group, the totals of items answered correctly on the achievement tests, the sample means, and standard deviations for each treatment component. The data are organized according to major treatment (lesson) juxtaposed with its moderating variable (musical pattern).

Table 6

Group 1: Items Correct, Mean Scores, and Standard Deviations

Lesson	Musical Treatment	Items Correct	Mean	SD
Machines	Incongruent	150	9.38	2.47
Forces	None	135	8.44	2.49
Energy	Congruent	146	9.13	3.67

Table 7

Group 2: Items Correct, Mean Scores, and Standard Deviations

Lesson	Musical Treatment	Items Correct	Mean	SD
Forces	Congruent	149	9.31	2.05
Energy	Incongruent	165	10.31	2.71
Machines	None	148	9.25	2.59

Table 8

Group 3: Items Correct, Mean Scores, and Standard Deviations

Lesson	Musical Treatment	Items Correct	Mean	SD
Energy	None	165	10.31	2.93
Machines	Congruent	152	9.50	1.62
Forces	Incongruent	146	9.13	2.64

The ANOVA prescribed (Kirk, 1982) was calculated to test for statistical significance of the effects of the forms of the independent variable, the forms of the moderating variable, and the other factors impacting the treatments, i.e., the groups and the order of treatment administration/repeated measures. The summary for the ANOVA is shown in Table 9. The factors A, B, and C represent respectively the lessons, the order factor, and the musical patterns. No factor produced a statistically significant effect.

Table 9

Computations for Type GLSFF 3^3 Design

Source	*df*	*MS*	*F*
Between blocks	47	528.667	0.027
Groups	2	13.792	
Blocks w groups	45	514.974	
Within blocks	96	510.333	
A	2	22.166	0.046
B	2	5.999	0.013
C	2	2.542	0.005
Residual	0	0.000	0.000
ABC X blocks w. groups	90	479.625	
Total	143	1039.000	

Subject Ratings

Students subjectively evaluated the interaction of the music and the lesson for both the congruent-music and incongruent-music treatments, by indicating on a 10 point scale whether they felt that the music, when present, made the content of the lessons more or less understandable. The t-test for nonindependent samples was run on the rating arrays for each group and for the total sample. There were no statistically significant differences in the subjects' ratings of these two musical patterns. In each case, the observed ratio was less than the t-value required to reject the null hypothesis.

Table 10 compares the ratings by group and for the total sample of the two musical patterns. Means, standard deviations and the t-value for these relationships are shown.

Table 10

Results of the t-tests

	n	Congruent		Incongruent		t
	X	SD		X	SD	
Group 1	16	5.81	2.23	6.38	2.16	-1.21
Group 2	16	4.88	2.16	4.81	2.93	0.12
Group 3	16	5.25	2.05	4.44	2.90	2.09
Total Sample	48	5.31	2.14	5.21	2.76	0.38

Table 11 compares the relationships between subject achievement scores and the associated ratings for each group and for the sample as a whole. In each case, the observed correlation coefficient was less than that required to reject the null hypothesis.

Table 11

Correlation of Ratings with Achievement Scores on Different Musical Patterns

Rating	Achievement	
	Incongruent	Congruent
Group 1		
Incongruent	-.17	
Congruent		-.14
Group 2		
Incongruent	.32	
Congruent		.14
Group 3		
Incongruent	.08	
Congruent		.00
Total Sample		
Incongruent	.09	
Congruent		-.04

Student Preferences

Individual student preferences were collected using a survey which included questions about music, science lessons and multimedia. The results indicated that the students generally study in the presence of music (77%). That was consistent with the report by 81% of the subjects that the musical patterns used in this experiment did not distract them. The failure of patterns of classical music to exercise a strong distraction effect is probably due to the high preference ratings given by the subjects to rap (40%), pop (17%), and light rock (14.5%). These are all forceful forms. % of the subjects of a liking for science lessons delivered in the fashion of this experiment. A large percentage (77%) of the students indicated that they liked the science lessons delivered this way and 73% indicated that they would take more science courses if they were delivered using multimedia.

Discussion

The purpose of this study was to assess the impact of music as an aid to learning. It attempted to enhance achievement by stimulating triple encoding in short term memory by aligning an abstract musical input, which elaborated subjectively on content (Burger,1993), with instructional strategy, a subjective lesson element. This research tested music in the role of a moderating variable, labeled Music-Instructional Strategy-Integration (MISI). The rationale for this moderating variable was to integrate abstract music with instructional strategy, a subjective lesson element, on the basis of psychological feelings. Participants viewed three multimedia science lessons that were designed using the instructional strategies of affective orientation and cognitive dissonance. Musical selections accompanied the lessons and were either congruent or incongruent with the psychological dynamics of the instructional strategies. Lessons were also delivered without music. The study assessed immediate recall and understanding of the lessons, students' subjective evaluation (rating) of the interaction of music in each lesson, and student preferences concerning music, science, and multimedia instruction.

The high MISI condition (music congruent with instructional strategy) was expected to enhance student achievement based on recent studies concerning the use of music in advertising (Kellaris, 1991; Kellaris, Cox & Cox, 1993; Kellaris & Kent, 1993) and in psychology (Boltz, Schulkind, & Kantra, 1991). A second expectation was for the low MISI condition to retard achievement compared to the no music condition. We did not find a statistically significant difference between the three conditions - high MISI, low MISI, or no music. This finding is also not in agreement with the research which regards music as a distraction (Zillman, 1994).

Students' rated the interaction of music in each lesson by answering the question "Did the music make the material in this lesson more or less understandable?" using a ten-point scale. Students were expected to find the incongruent music distracting and to therefore think that the music made the lesson less understandable in the lessons with low MISI. It was also expected that students would think that the music made the lesson more understandable in the lessons with high MISI. These expectations were not fulfilled based on the statistical analysis. This finding is, however, consistent with student performance on the achievement tests and may provide an explanation for our results.

This study ratified the popular notion that ninth grade students prefer instruction with a musical ingredient. It also found that students believe that music adds to lesson effectiveness and that the inclusion of music can stimulate positive student affect toward computer-supported science instruction.

There are several possible explanations for why the insertion of music which was congruent with the psychological operation of the lessons' instructional strategies did not improve performance. One consideration in this study was the choice of classical music. We purposefully chose music that was not familiar to these students. Familiar music could possibly be more distracting and might carry an affective association. The results from the students' subjective ratings of the music, however, showed that they may not have distinguished between the congruent and incongruent treatments. The use of classical music with this particular group of subjects may have acted similar to background music.

The failure of this technique to produce a significant effect could suggest that multiple encoding is an objective, content specific phenomenon, not under the influence of subjective lesson attributes. This study suggests, therefore, the need for a similar investigation of multiple encoding using only literal music. Literal music depicts content by becoming one of its objective parts as in a sound effect (Burger, 1993).

In designing this experiment, we purposely used a simple dissemination strategy rather than embellishing the lessons with components that are known to improve performance, (e.g. practice, feedback, interactivity). We did this in an attempt to avoid a "no significant difference" finding due to a ceiling effect. It is possible, however, that the efficiency of the instructional design employed and the impact of the visual elements for these lessons fully executed the psychology of the instructional strategies so that no room was left for the music to contribute to those psychological dynamics. This study suggests the need for further experimentation with music as an agent in dual encoding where the music is associated with only one other message element such as text. A related but different explanation is the possibility of a novelty effect associated with multimedia delivered instruction. These students were not used to this delivery mode in their classroom. The uniqueness of these lessons together with the short length of the lessons, may have held their attention more than if it were a common or lengthier occurrence.

This investigation clearly demonstrated that adolescents prefer to have music present in their academic activities and may be more interested in science courses which utilize the use of multimedia. This finding together with the mixed results of research about the best way to integrate music into instruction strongly suggests the need for further studies.

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APPENDIX A

Musical Compositions

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Bach, J. S. Sinfonia (Cantata No. 156). On Baroque favorites {CD}. New York: CBS Records. (1983)

Bach, J. S. Air for the G-string (Third Orchestral Suite). On Baroque favorites {CD}. New York: CBS Records. (1983)

Beethoven, L. Egmont (Op. 82). On Famous Classical Overtures {CD}. Los Angeles: LazerLight Digital. (1989)

Beethoven, L. Overture to Fidelio (Op. 72). On Famous Classical Overtures {CD}. Los Angeles: LazerLight Digital. (1989)

Berg, A. Chamber music for piano, violin, and 13 wind instruments. (Cassette Recording No. P4C7179). New York: Quintessence.

Berg, A. Concerto for violin and orchestra. (Cassette Recording No. P4C7179). New York: Quintessence.

Elgar, E. Pomp and circumstance (Op. 34), Military march no. 4 in G-major {CD}. Hamburg: Deutsche Grammophon. (1992)

Elgar, E. Nimrod. On Enigma variations (Op. 36) {CD}. Cleveland: Telarc. (1989)

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Holst, G. (1917). Venus and Jupiter. On The Planets {CD}. London: DECCA Record Co. (1979)

Marcello, A. Adagio (Oboe concerto in D-minor). On Baroque favorites {CD}. New York: CBS Records. (1983)

Rossini, G. Overture to the Barber of Seville. On Famous Classical Overtures {CD}. LazerLight Digital. (1988)

Tchaikovsky, P. March slav (Op. 31). On Great Classical Marches {CD}. Los Angeles: LazerLight Digital. (1988)

Vivaldi, A. Largo. On Baroque Favorites {CD}. New York: CBS Records. (1983)

Title:

Electronic Mail: An Examination of High-End Users

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Introduction

Over the last ten years, electronic mail (email) has provided a new vehicle for communication. As D'Souza (1992) stated, electronic mail has become a mainstay of organizational communication. Its four essential characteristics, she continues, namely cost reduction, reduced paper handling, faster communications, and improved communication effectiveness, have attracted users both from businesses and academia.

At Indiana University alone, there are over 40,000 active accounts. These include student, faculty, and staff accounts. It is estimated that over 80% of these accounts are active, and 99% of them are used for electronic mail. Mark Sheehan of University Computing Services at Indiana University mentioned that email has been in common use among students only since 1988 when there were only 8,000 computer accounts issued.

From reviewing the literature on electronic mail, we found that researchers have not made a distinction between users who use electronic mail many times during the day (high-end users), and casual users (low-end users). Therefore, research findings on how people use and feel about electronic mail have been reported without considering whether the amount of usage is a factor in the participants responses.

Therefore, for this paper, the scope has been narrowed to high-end users. The researchers set out to discover what high-end users (students and faculty only) do with email and how they feel about it. It is our hope that in the future similar studies will be conducted with low-end users, in order to be able to compare and contrast studies.

Literature Review

There is a respectable volume of research that is devoted to the use of email in academic settings. Poling (1992) encourages students and professors to use electronic mail to their advantage for classroom purposes. He firmly believes that educators can build a stronger relationship with students by simply spending a few minutes each day using email to communicate with their students. Moreover, many other researchers, including D'Souza (1992), Ruberg and Miller (1993), and Lowry, Koneman, Osman-Jouchoux, and Wilson (1994), suggest that students and faculty use electronic mail for all of the following: answering direct questions from any student, counseling, class assignments, general class announcements, occasional quizzes, direct communication with a particular student, posting grades, helpful hints about homework or upcoming quizzes or tests, and excuses for missing class.

Nevertheless as Ruberg and Miller (1993) stated, direct communications such as electronic mail may resolve some communication problems, but it may also introduce some others. For example, the physical aspects/personalization of communication such as face-to-face interactions and hard copy formats are lost, and some users of email complain about information overload preventing them from managing all the email they receive.

Design of Study

Sample

Our sample consisted of 12 people in the Instructional Systems Technology (IST) department at Indiana University. We chose IST faculty and students because we recognized that they represent a unique population. First, the students in IST are required to pass a computer proficiency which includes email. Second, the faculty and students depend on email as the sole medium for posting job announcements, class announcements and community events. Third, IST as somewhat unique because of the high-end use of computers. Each of our subjects checked their email daily. Fourth, members of the IST community represent a large number of students from different backgrounds. Not only are there students from around the world, but also from many disciplines. Finally, the fact that IST is a graduate-only program makes it unique.

We divided the IST department into three major groups, the faculty (F1-F4), non-first year students (S1-S4), and first year students (S5-S8) and chose four subjects to represent each group, F1-F4 and S1-S8. Within this sample, we tried to mirror the diversity of IST. Overall, we had five females and seven males. Nine of our subjects were American, the other three were international students.

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The choice to split up the students into non-first year and first year was based on the assumption that length of experience with email may influence opinion. Many of the first year students may be newer to the technology than the established students. The faculty were chosen because their point of view is relevant to the way IST uses email, yet potentially differs from the ideas of the students.

Procedure

The four researchers each interviewed one member from each of our major subject groups. Each interview was audio taped. We asked our respondents how often they send and receive email, how they use it, and how they feel about email. The researchers then transcribed the interviews and returned them to each respondent for a member check.

Once the member checks were completed, the researchers broke the transcriptions into idea units and placed them on note cards. The question that was being answered in each case was also put on each notecard to ensure that the information was not being taken out of context. Finally, the notecards were grouped and sorted into categories. From there, the analysis took place.

Findings

Frequency of Use

All of the subjects reported checking email at least once a day. Most of them report checking it two to ten times a day. Two of the faculty members keep email open all the time. This means that they are, in essence, checking their email constantly.

The subjects report receiving generally five to forty email messages each day. However, they only claim to send two to ten messages each day. Several of the respondents mentioned that a lot of the email they receive is from listservs they are subscribed to. This helps explain the discrepancy between the number of messages sent and the number of messages received.

Purpose of Use

When the data was analyzed, three major categories of usage emerged. Our subjects generally use email for personal communication, class related communication and collaboration with colleagues.

Personal

In the area of personal use, email proves to be a cheaper means of communication than long distance phone calls and is more likely to be written and sent than a letter. Several of the subjects acknowledge that it is email that allows them to keep in touch with people who would have fallen out of their lives. As one person pointed out, "I never would have had any track of them (friends from high school) at all." (F1) Another person also says that email helps her keep in touch with "a person you like, but they are not intimate enough to spend long distance money on." (S3)

In a related use, one international student mentioned that while she was adjusting to life in Indiana, email become her connection with her home:

> When I first came here, I was using it a lot to send messages to my friends in Taiwan. In the beginning, when I came here, I was feeling very lonely so I was using it to talk to my friends a lot, but now I feel comfortable here, so I don't use it as much as before. (S7)

In personal communications, besides the economic benefit, there are two other benefits to email that were stated by our subjects. First, the ability to send it to many people at once. This allows for easier handling of logistics such as planning group meetings. Next, the subjects mentioned the ability to use listservs. One faculty member stated:

> From what I've seen, most listservs tends to have one or two people on them that know what they're talking about, and hundreds and hundreds of people who don't -- who are either asking questions, or

> they are getting on there and they are sort of yammering the same platitudes, truisms that they read in *Newsweek* last week. (F1)

But, she continued that she benefits from this kind of communication with people who have similar interests.

Class Use

Both our faculty and student respondents applaud email for class uses. The students report that it is a wonderful way to organize group and project activities and meetings. They also like using email to communicate with professors. One student stated

> I would be less inclined to go and talk to a professor. I would be more likely, I mean definitely more likely, to send them an email than to call them. I would probably never call a professor, but I would probably go into their office before I would call them. But, sending an email is no big deal. (S6)

The students also use email to continue class discussions, thereby extending learning beyond the walls of the classroom. Finally, a few students mentioned that they sometime submit assignments via email.

Like the students, the professors like email's effect on class communications. They mentioned the convenience of sending out class information over email instead of trying to find a different way to communicate with the students. They are also able to answer the student's questions both quickly and at their own convenience. As one professor mentioned:

> Where formerly a student may have made an appointment or I would have felt compelled to have office hours where I sit in the office and stare at the door and make sure I don't do anything else because that's the only time students can get at me. Now I know students who have questions can ask them 24 hours a day and I can answer them, sometimes in the middle of the night or . . . on weekends.(F3)

The professors, like the students, also mentioned the expansion of learning time past the one to three hours reserved for classes.

Collaboration

Finally, both students and faculty cited collaboration as a major use of email. They use email to consult with other professionals and students, make initial contacts with people who they would like to collaborate with, organize projects, and maintain contact with colleagues. Perhaps the best summary of the strength of email for these kinds of activities comes from one professor who said, "(email is) especially nice, for instance, in the case of [a colleague] in Venezuela. There's hardly any other way to talk to Venezuela. The phone system doesn't work well - the mail doesn't work at all." (F3) He goes on to state that because of email, this colleague is able to serve on an IST student's dissertation committee.

Feelings About Use

Once the data was interpreted and separated, there appeared to be five distinct categories that people's feelings about email use fit into. On the positive side, they claimed they like email because it is unobtrusive and convenient and efficient. The negative feelings included email being overwhelming, it is problematic to communicate feelings via email and email is not useful for complex issues.

All of our subject mentioned the convenience of using email. They really enjoy the freedom of being able to ask questions whenever they want, and being able to answer questions at their leisure. Because email is unobtrusive, no one hesitates to end an email if they need to communicate with a colleague or student/professor. As one student (S3) stated, "I think that I like email because it's unobtrusive -- because when somebody's checking their email, they are choosing to check it and they can determine what they want to do with the message." This same student reemphasized her point by stating that "it's (email) is different than calling someone on the phone, because a person can't control when they are going to get a phone call, but you can control when you check your email, and how you want to deal with it." This feature of email makes it a very convenient communication device.

The efficiency of email makes it highly appreciated. Email allows the sender more time to formulate questions and be sure the question being asked is the intended question. It also provides a means for people to get answers faster than they would if they had to reach a person by telephone or personally. As one professor pointed out, "I think that's a neglected attribute of email – that it can answer problems more quickly than you might otherwise do face-to-face." (F3)

The major complaint about email that our subjects offered is that they receive too much of it. They mainly blame listservs for the bulk of their email. As one faculty member summed up the situation:

> The whole backside of email is managing the incoming and outgoing messages . . . that's a whole other world of use and a troublesome one . . . it's a huge clerical job that lands on your desk all of a sudden, and I don't really know to what extent we fall backwards into our picture of how people spend their work time, but it's there. (F1)

Communication of feelings is another area in which email falls short. As a faculty member pointed out, "We've all had bad experiences or misunderstandings, hurt feelings over something that someone typed and it didn't come across right to the other person."(F1) Several of the students also found this to be a problem.

Finally, our subjects felt that email is not appropriate for complex issues. One student summarized this point of view by stating, "There are certain sorts of chit-chatty things you just can't type at all." (S3)

Conclusions

There are several conclusions that can be drawn from this research. First, there is a problem with a deluge of email. Unlike D'Souza, we found that email is an additional form of communication. It has not replaced any other forms, merely provided a new form. In fact, as Ruber and Miller pointed out, email has caused some new communications problems. For instance, several of our subjects mentioned that it has caused a redundancy in communication. For instance, they receive a phone call telling them to check their email which contains a letter which has also been faxed to them. This is not an effective use of the technology and does not improve the effectiveness of their communication.

Next, there is definitely a cost and time efficiency benefit to using email. Our data matched D'Souza's findings – email provides faster communications. It also allows the sender and receiver the freedom to deal with their questions at their own convenience instead of having to coordinate with other people to meet them face-to-face.

Finally, we noted that our subjects report that their feelings about using email have changed over time. Each of them reported being very excited about using it at first. They sent messages to everyone they knew who had email because it was fun and exciting. After even a few months of using email, they view it merely as a communication medium. They feel it is something that needs to be dealt with daily. While they are not unhappy about having email, our subjects are not excited by it anymore either.

Future Research

This report focuses only on a very narrow group of email users. In the future, research should be done to find out how other groups of people feel about email. It would be interesting to compare high-end users to low-end users not only int he ways they use the medium, but also how they feel about the medium. Another area of research would be to compare use of email to that of other communication mediums – especially looking at the frequency of use and types of use for each.

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Title:

Cognitive Strategies and the Use of a Hypermedia Information System: An Exploratory Study

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Abstract

The purpose of this study was to identify the strategies used by learners in an open-ended hypermedia information system. Four participants were drawn from an introductory technology course incorporating a unit on telecommunications. Participants completed a survey measuring reported knowledge in three domains (metacognitive, system, and subject) as well as self-efficacy toward technology. Participants searched for information using *Netscape®*, thinking aloud as they searched. Data were collected; analysis occured in several phases: scripting the search, reading through the data, segmenting according to research question, and encoding. Three major findings related to hypermedia information systems resulted from this study: a variety of strategies are used by learners; reported knowledge does have an affect on the strategies used; and perceptions of disorientation and level of perceived self-efficacy have an affect on the strategies used. Implications related to emerging information technologies, open-ended learning environments, and the ways learners think are considered.

INTRODUCTION

Interest in creating productive and stimulating learning environments is an enduring theme in the educational arena. Recent attention has focused on open-ended learning environments (OELEs). In OELEs, experience and context are critical for cultivating cognitive processes that support understanding. These environments are learner-centered, with the instructor adopting the role of facilitator as opposed to presenter. The learner is encouraged to explore and experiment; problem solving, critical thinking, and perspective-building are inherent processes in these environments. While learning outcomes remain important to knowing, processes are the focal point of growth in understanding (Hannafin, Hall, Land, & Hill, 1994; Papert, 1993).

The emphasis on cultivating processes and strategies increases the requirement for learner-supplied structure. While the instructor or system can assist by guiding and facilitating, the learner determines which tools and resources to access and manipulate; that is, how to navigate to promote learning (Bransford et al., 1986; Spiro, Feltovich, Jacobson, & Coulson, 1991). The individual determines what s/he wants or needs to know, for accessing the information in the system, and for deciding whether or not the system contains the needed information (Perkins, 1993; Roth & Roychoudhury, 1993).

Numerous information systems exhibit some characteristics of OELEs. These systems blur traditional distinctions between educational systems and information retrieval systems. They have become increasingly transparent and user-centered. Emerging information systems provide the user with more control through "point and click" technology, and expand the retrievable resources to include multiple media.

Emerging information systems do more than archive and retrieve data; they support the individual's efforts to learn, think, and understand (Hannafin, 1992). These systems are no longer the exclusive domain of information scientists. They are readily accessible and usable by the consumer, creating both extraordinary opportunities for student-centered learning, as well as formidable challenges for those who design and develop such systems.

The challenges associated with creating electronic information systems that function as OELEs are considerable. Some systems are simplistic and focused; others are complicated and virtually limitless in breadth and depth. Designing and developing electronic information systems that empower the user, are intuitive and self-evident, and inclusive in orientation is a formidable challenge (Norman, 1988). It has also proven difficult to assist and support the learner in their uniquely individual goals as they use such systems. Learners accustomed to interacting in environments that are prescriptive and directed are often inefficient and ineffective in their use of and interactions within open-ended, learner-centered environments. They may lack the orientation, mental model, or strategies necessary for the environments (Hill, Lebow, Driscoll, & Rowley, 1994).

Another concern is that emerging information systems have evolved despite the absence of a strong theoretical or research foundation. We lack a solid understanding as to how or why the systems are being used. In addition, we lack a clear conceptualization of the capabilities and/or features that are needed or desired.

The purpose of this study was to identify the strategies used by learners seeking information in an open-ended hypermedia information system. The following questions provided a framework for this study.

Primary Question

What strategies are employed in open-ended hypermedia information systems?

Secondary Questions

1. Does metacognitive knowledge affect the strategies employed?
2. Are perceptions of disorientation influenced by the strategies employed?
3. Does perceived self-efficacy affect the strategies employed?
4. Does system knowledge affect the strategies employed?

5. Does subject knowledge affect the strategies employed?

METHODOLOGY

Selection and Description of Participants

The population of this study were current and prospective educators enrolled in a university-level technology for educators course. This included Pre-K through 12 public school teachers as well as college/university instructors. This sample and population was chosen for several reasons: a lack of research examining adult use of hypermedia information systems, willingness to participate in an intensive study, and diversity of the participants. The university serves both undergraduate and graduate students from the state, region, and nation, as well as international students. The students reflected a broad range of experiences and backgrounds, assuring diversity in the population.

The Course: Technology for Teachers

"Technology for Teachers" attempted to create the conditions under which people typically understand things: first they develop a need to learn, then subsequently satisfy the need through progressive experiences. The course operated under several important premises. First, within educational settings, technologies are not so much a curriculum as sets of tools which can be put to productive uses. The course worked to help learners to establish what those productive uses might be.

Another premise was that productive use is influenced by context, audience, and activity. Problems presented during the course were anchored in everyday classroom teaching and learning contexts for which various technologies can be employed for, and with, students, teachers, and communities. The goal was not to become an expert in technology, but to become more facile in teaching through technology.

The final premise was that it was critical to understand the processes associated with various technology applications. Technology continues to advance at an exponential rate. Existing technologies will inevitably be replaced by systems that are faster, and more powerful. Therefore, problem solving and cognitive strategies for the use of technology were highlighted, rather than mastery of specific software and hardware.

Technology for Teachers was chosen for several reasons:

- Since the course was an elective, most students, both undergraduates and graduates, entered with a high level of interest and motivation.
- Given the recent movement to integrate technology into the classroom, the learners entered with a high degree of interest in learning various technologies, as well as diverse techniques for applying technology in their individual settings.
- The course itself reflected the assumptions and principles associated with open-ended learning environments (OELEs), including the development of cognitive strategies and higher-order thinking skills (see, for example, Hannafin, Hall, Land, & Hill, 1994). An inherent aspect of OELEs is that the learners establish goals they want to accomplish, as well as determine the steps needed to attain the goals. The course naturally supported the participants in the use of hypermedia information systems.
- Telecommunication technologies were integral to the course activities. A major focus of the unit was the Internet. Most learners were aware of the Internet, even if they did not understand what it was or how it could be used in an educational setting. The majority had a high degree of curiosity and motivation to learn about the Internet , what it can do, and the ways in which it can be used.

The Information System: Netscape®

The system selected for the study was Netscape®, a hypermedia information system built upon World Wide Web(W3) technologies. The system displays the following characteristics:

- open-ended in nature, providing access to a variety of information and media
- requires generative activities, placing the learner in the driver's seat
- necessitates an orientation toward discovery, where the learner is free to explore vast resouces
- control of the environment centers around the user, both in terms of the information requested and the steps taken to retrieve the information

The World Wide Web is an interconnection of computer sites on the Internet. The main difference between World Wide Web technologies and traditional Internet programs is that W3 allows for the transmission of pictures, sound and motion along with traditional textual information. It also differs from traditional Internet programs in that it creates a point and click interaction environment, where a mouse or track ball can be used to retrieve information. This creates an environment where hypertext and/or hypermedia capabilities are readily accessible.

Netscape® is a front-end browser used to interface with the Web. Netscape® and W3 operate in a client/server environment: the program that resides on the local computer is the client, while the server is the remote location accessed. Netscape® is the browser that displays the information retrieved from the Web.

Method and Design

An embedded case study approach was employed, involving the use of multiple cases, or embedded units, within a larger context. The unit of study in this case was the individual user of the system from whom several data sources were gathered. A unique strength of the case study strategy is the ability to deal with multiple sources of evidence. Various sources of evidence from the embedded units allowed for triangulation of the data, as well as serving to address concerns with construct validity (Yin, 1994).

The methods combined exploratory, descriptive, and analytical approaches. The study was exploratory in that several of the methods have not been previously used to examine the use of strategies in hypermedia information systems. The research was descriptive in that the goal was to describe the strategies employed from the evidence gathered, including the perspectives of the participants and the researcher. Information gathered during the research was manipulated iteratively through analytical induction. Initial definitions and explanations were developed at the beginning of the study. These definitions and explanations were then contrasted with the data collected and refined based on analysis of the evidence (Bogdan & Biklen, 1992).

Measures and Instrumentation

A combination of rationalistic and naturalistic techniques was used. Rationalistic (quantitative) techniques, including surveys and questionnaires, were used to generate individual difference measures for each case, and audit trails were used to track the participants' movements as they searched using Netscape®. Naturalistic (qualitative) techniques, included think-aloud protocols and interviews. These methods were used to monitor the participants' search, as well as to capture their thoughts both during and after the search process.

A fundamental theme in naturalistic studies is the element of continuous improvement. It is a widely held belief in qualitative research that research is a process that occurs on a continuum, one moving ever closer to a contextual reality. In keeping with this theme, and to assist the researcher in creating a more complete picture of contextual reality, the techniques described below were first used in a developmental study.

Figure 1 illustrates the progression of the activities throughout the study. Several activities took place during the study, which can be divided into three main components: pre-search activities, activities during the search, and post-search activities. Five techniques were used to gather data: pre-search surveys, think-aloud protocols, audit trails, post-search questionnaires, and stimulated post-search interviews.

Pre-search survey. The pre-search survey measured the learners intial perceptions of the three domain areas (metacognitive, subject, system) as well as their perceived self-efficacy.

Think-aloud protocols. Think-aloud protocols were recorded on both audio and video tape as the learners worked in the hypermedia information system. Learners were encouraged to verbalize whatever came to mind as they worked in the system.

Audit trails. Video was used to record the learner's path in the World Wide Web. The recordings were used to generate audit trails of the search.

Post-search questionnaires. Like the pre-search survey, the post-search questionnaire measured the learners perceptions of the three domain areas (metacognitive, subject, system) as well as their perceived self-efficacy. In addition, the questionnaire examined the learner's perceived strategies as they worked in the system.

Stimulated post-search interviews. Following the transcription of protocols and the creation of audit trails, learners were interviewed to garner their reflections, reactions, and comments on the search task.

See Appendix B of the *1996 AECT Proceedings*

The techniques enabled the researcher to establish a rich orientation to the individual's search process, procedures used, and strategies engaged. Those techniques were used to determine the five self-reported knowledge areas: disorientation, perceived self-efficacy, metacognitive knowledge, system knowledge, and subject knowledge.

Disorientation. Disorientation refers to a loss of one's bearings. Disorientation is often associated with a lack of understanding, or an inability to recognize how to use the system to accomplish one's goals.

Perceived self-efficacy. Self-efficacy refers to a person's perceptions of ability to succeed on a given task. Perceived self-efficacy refers to a person's judgments of her or his capabilities to organize and execute action required to attain designated performance (Bandura in Olivier & Shapiro, 1993). Perceived self-efficacy transcends knowing what to do or awareness of one's skills; it is a judgment of how well one can perform using particular knowledge or skill.

Metacognitive knowledge. Metacognition refers to awareness about cognition. Metacognitive knowledge enables an individual to reflect, evaluate and direct cognitive activities more effectively (Perkins, Simmons, & Tishman, 1990). In this study, metacognitive knowledge referred to the participant's self-reported awareness of their cognitive processes. Users with extensive metacognitive knowledge were presumed able to monitor their learning needs, leading to purposeful system use.

System knowledge. System knowledge refers to the participant's reported knowledge about electronic information systems in general, as well as Netscape®, in particular. System knowledge was felt to influence the ability to search successfully in an information system. Users with extensive system knowledge, such as reference librarians, are often able to use it to maneuver through information systems, despite a lack of significant prior subject or domain knowledge.

Subject knowledge. Subject knowledge refers to estimates of existing knowledge and experience related to the subject for which searches were conducted. Subject knowledge was presumed to influence the strategies participants employed as they searched using Netscape®.

METHODS, ANALYSIS AND PROCEDURES

Data analysis was conducted at several stages. The developmental study provided an opportunity to test the clarity of the questions and terminology, the techniques employed with the think-aloud protocol, and the accuracy of the technology employed to gather data. It also provided insight into the strategies being employed as people work in these systems.

Primary Research Phase

Preliminary Organization and Analysis

Most of the collection, organization, and analysis of data occurred concurrently. This helped to indicate gaps in data as they were gathered and organized, allowing adaptations in the process and indicating the need for additional information (see, for example, Glaser & Strauss, 1967; Hert, 1992). Formal analysis, comprising several reviews of the data, took place toward the end of data collection (Bogdan & Biklen, 1992). Overall organization of the data gathered in relationship to the research questions is illustrated in Table 1.

Table 1. Research question, data sources, and methods

Research Question	Data Gathered	How Obtained	When	Who
1. Does metacognitive knowledge affect the strategies employed?	Written responses to several questions	Pre-Search Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-search Question.	Post-search	Participant
	Verbal responses to several questions	Stim. Post-Search Inter.	Post-search	Participant & Researcher

Table 1. (continued)

Research Question	Data Gathered	How Obtained	When	Who
2. Are perceptions of disorientation influenced by the strategies employed?	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-Search Question.	Post-search	Participant
	Verbal responses to several questions	Stim. Post-Search Inter.	Post-search	Participant and Researcher
3. Does perceived self-efficacy affect the strategies employed?	Written responses to several questions	Pre-Search Survey	Pre-search	Participant
	Written responses to several questions	Post-search Ques.	Post-search	Participant
	Verbal responses to several questions	Stim. Post-Search Inter.	Post-search	Participant and Researcher
4. Does system knowledge affect the strategies employed?	Written responses to several questions	Pre-Search Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
5. Does system knowledge affect the strategies employed?	Written responses to several questions	Post-search Questionnaire	Post-search	Participant
	Verbal responses to several questions	Stimulated Post-Search Interview	Post-search	Participant and Researcher
6. Does subject knowledge affect the strategies employed?	Written responses to several questions	Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-search Questionnaire	Post-search	Participant
	Verbal responses to several questions	Stimulated Post-Search Interview	Post-search	Participant and Researcher

Table 1. (continued)

Research Questions	Data Gathered	How Obtained	When	Who
Overall Question: What strategies are employed in open-ended hypermedia information systems?	Written responses to several questions	Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-Search Questionnaire	Post-search	Participant
	Verbal responses to several questions	Stimulated Post-Search Interview	Post-search	Participant and Researcher

Transcripts of the think-aloud protocols, as well as the video-taped search sessions, were generated. Think-aloud protocol transcripts provided a verbative translation of the audio tape. Transcription of the video tapes involved a step-by-step recounting of the participant's movement through the information space. The information gathered from the video tapes was transformed into a search trail generated using the program Inspiration®. Locations visited by the participant during the search are represented as nodes in the map.

Preliminary analysis took place as transcriptions were generated. A participant summary sheet was used to summarize this analysis and to assist in organizing the data (McGregor, 1993; Miles & Huberman, 1984). The summary sheet addressed each research question according to the instrument examined, directing the researcher to summarize the main points from the survey in relation to: metacognitive knowledge, perceived self-efficacy, system knowledge, and subject knowledge.

Stimulated post-search interviews were scheduled one week after completion of data collection. Initial analysis of the think-aloud protocols and search trails helped to guide the formulation of additional questions appropriate for individual interviews. Video tapes were shown during the interview to stimulate the participant's recall of particular instances in the search process.

Data were examined with an orientation toward both breadth and depth. In order to obtain breadth and depth, the initial pool of 14 participants was reduced to four for in-depth analysis. The researcher reviewed the participants' data in relation to the research questions, the performance of each participant in the think-aloud process, and the need to represent the range of participants in the study. The four participants chosen for in-depth analysis were Mick, Bill, Marsha, and Alyssa. As shown in Table 2, each reflected different estimates of the various knowledge described previously. The high, mid, and low designations for the participants reflects an overall ranking ("average") based on level of disorientation, perceived self-efficacy, and self-reported knowledge in the areas of metacognition, system and subject. Names of the participants were changed to protect their identify.

Table 2. Summary of participants reported knowledge, overall ranking, and "success"

Participant	Metacognitive	Disorientation	Self-Efficacy	System	Subject	Overall Ranking	Success Rating
Alyssa	mid	high	low	low	mid	low	no
Bill	high	mid	mid	low	mid	mid	yes
Marsha	low	mid	mid	low	low	mid	no
Mick	high	low	high	low	high	high	yes

In-Depth Analysis

Given the variety and volume of evidence gathered, techniques of examination, categorization, tabulation and recombination were used throughout the analysis. Copies of original data sets, as well as records of each transformation, were used to maintain the integrity of the data during analysis iterations. The data were reviewed and triangulated several times by the researcher; each time the data were examined, additional relevant information and related findings were revealed.

The initial in-depth analysis was driven by the need to combine the think-aloud protocols and the search trails. A "script" format, often used in screen plays, movies, and television was used to merge the elements. The scripts were used throughout the remainder of the analysis to aid the researcher in identifying themes, patterns, and strategies.

The next round of analysis involved several stages, including reading through the data, highlighting instances in the data related to the research questions, and generating case reports for individual participants (Bogdan & Biklen, 1992; Harmon, 1992; Yin, 1994). "Reading through the data" involved a review of all data elements, "reading" the instruments like a book. Initial themes and patterns were identified.

Data were marked-up (segmented) in accordance with the research questions during the next phase of analysis. As the researcher read the data, multi-coloured highlighters were used to mark-up the data according to research questions (see, Ericsson & Simon, 1984, for a description of the mark-up process).

The sections of the scripts related to specific research questions were then coded. A mixture of established and data-driven codes were used during this stage. The "established" codes were derived from other information seeking studies, including information-processing research, information-seeking models, and interactive strategy research. These codes relate to strategies and actions taken by users of information systems. Themes and patterns not readily applicable to established categories were assigned a new category.

At this point, the researcher asked participants to confirm the validity of themes, patterns, and strategies (Bogdan & Biklen, 1992; Mathison, 1988). Inclusion of the participant in the research process is a fundamental element in qualitative research. To facilitate feedback from each participant, individual case reports were generated. Each participant was asked to review the report and to generate questions or concerns for discussion with the researcher. Verification from the participant is valuable in improving the validity and reliability of a study.

One week after the reports were distributed, the researcher met with each participant to discuss the case reports. Results of these meetings indicated a high degree of researcher-participant agreement. Recommendations from each participant were noted during the interviews; where indicated, changes and/or additions were made to the data sets for each participant.

The final stage of analysis involved the collation of data according to the corresponding research questions. Each data source, organized according to research questions, was re-analyzed to match and clarify patterns. Pattern matching involves examination for similarities in the thoughts and/or actions of the participants. Codes were assigned to the strategies in the transcribed protocol. Examination of the coded protocol was undertaken to identify trends in the data. This process, repeated for each participant as well as across participants, enabled the researcher to identify trends in strategies as they related to each research question.

In order to interpret the meaning of participants' actions, the technique of explanation building was used. Explanation building involves returning to the data to seek explanation for why participants thought or acted during the search process. Returning to the data for explanation helped to establish the creation of assertions related to the study.

Analysis of global patterns and trends was necessary to address the overall research question. To assist the researcher in theorizing on a global level, two methods of aggregation were used (Ericsson & Simon, 1984): aggregation by episode and aggregation by process. In aggregating the data, the researcher merges individual cases into one instance. In this study, aggregation was completed around two data points: similar episodes in each search and similar processes used by each learner.

The final stage of the analysis process involved cumulative data analysis, where all trends, issues, and themes generated during the analysis are examined as complete units relating to each research question. From these data, the researcher generated speculations and explanations of the strategies used by learners as they search in hypermedia information systems.

FINDINGS AND RESULTS

The results of the study were constructed from the theoretical foundations of grounded theory. Grounded theory involves building explanations from the data themselves (Glaser & Strauss, 1967). Pattern matching techniques were employed during the iterative analysis process as a way of making sense of the data. Analysis of the data yielded several assertions.

Assertions By Research Area

Assertion 1: Perceptions of disorientation affect the strategies employed in a hypermedia information system. Several learners reported feeling "lost," or "being in the middle of nowhere" when they were using the system. This disorientation, in turn, affected search decisions.

Assertion 2: Prior subject knowledge is directly related to concept recognition and affects the strategies employed. Learners with high subject knowledge readily recognized terms related to the search topic. This impacted what they pursued in the system and how they used the program.

Assertion 3: System knowledge has direct impact on the strategies the learner is able to develop as they seek information in a hypermedia information system. What the user is able to do with the system is directly tied to their knowledge and experience with the system. Development of strategies takes time; learners with higher system knowledge were able to develop strategies easier and quicker.

Assertion 4: Level of metacognitive knowledge influences strategy refinement. Learners with high levels of metacognitive knowledge were able to reflect on their process. This reflection enabled them to refine their actions and make better use of the system.

Assertion 5: Self-efficacy affects willingness to engage in hypermedia exploration. Learners with high levels of self-efficacy engaged in more exploration of the system. This increased exploration afforded more opportunities, increasing prospects of finding the desired information.

Results By Research Questions

Overall Research Question: What strategies are employed in open-ended hypermedia information systems?

This "meta-question" was informed by the secondary questions. However, the findings can be summarized into three trends:

- A variety of strategies are used by learners as they seek information in a hypermedia information system.
- Metacognition, system and subject knowledge affect the strategies used.
- Perceptions of disorientation, as well as perceived self-efficacy, affect the strategies used.

Specific findings are presented as they relate to each research question.

Research Question One: Does metacognitive knowledge affect the strategies employed?

Of the prior knowledge areas examined, metacognitive knowledge most influenced the strategies used while searching using Netscape®. Level of metacognitive knowledge seemed to corresponded to success in system use. Learners who used the system effectively were active information processors and comprehenders who monitored their learning activities (Osman & Hannafin, 1992). They also experienced less disorientation. Mick consistently monitored his thinking and revised his actions accordingly, and also made significant progress with the strategies used and understanding of the search process. Mick engaged in several metacognitive tasks described by Wang, Haertel, and Walberg (1990): comprehension, monitoring, use of self-regulation, self-control strategies, and use of the strategies to facilitate generalization.

All learners reported metacognitive experiences during their search tasks. According to Flavell (1979), a metacognitive experience is any conscious cognitive experience that accompanies and pertains to an intellectual enterprise. His illustration of a metacognitive experience directly relates to what the participants experienced while searching using Netscape®: "To illustrate, you may experience a momentary sense of puzzlement that you subsequently ignore, or you may wonder for some time if you really understand what another person is up to" (p. 908). Both the sense of puzzlement and wondering about understanding were experienced by all of the learners in the study.

Interestingly, the manner in which metacognitive experiences were processed influenced whether, or how, metacognition influenced the search task:

> Some metacognitive experiences are best described as items of metacognitive knowledge that have entered consciousness. As one example, while wrestling with some stubborn problem, you suddenly recall another problem very like it that you solved thus and so. Some metacognitive experiences clearly cannot be described that way, however. For instance, the feeling that you are still far from your goal is not in itself a segment of metacognitive knowledge, although what you make of that feeling and what you do about it would undoubtedly be informed and guided by your metacognitive knowledge... (Flavell, p. 908).

This differentiated Mick from the other learners: not only did he have prior experience, his actions were informed and guided by his high level of metacognitive knowledge.

While the importance of metacognitive knowledge is clear, the implications are not. Some advocate teaching metacognition knowledge for skill (Osman & Hannafin, 1992; Wang, Haertel, & Walberg, 1990); others have trained students to effectively monitor their learning (Brown & Palincsar, 1989; Paris, Cross, & Lipson, 1984). Still, the results are inconsistent; recommendations for teaching or training are often suspect. While results of this study confirm its importance, further investigation is needed to determine the best ways to instruct learners in the use of these skills.

Research Question Two: Are perceptions of disorientation influenced by the strategies employed?

The perception of disorientation yielded one of the strongest influences on the strategies employed. High levels of disorientation can lead to dysfunction as well as overall dissatisfaction with the search process. This is not only debilitating, but also serves to elevate frustration.

Alyssa's high level of disorientation and dissatisfaction with the search process provides the most compelling evidence for this conclusion. Her failure to retrieve relevant information, in addition to her use of low-end, basic strategies, suggests disorientation has a seriously detrimental influence in the use of emerging information systems.

This study provided more evidence for the phenomenon: "lost in hyperspace." This occurred independent of the level of reported knowledge. Several researchers have discussed its negative consequences on usability (see, for example, Jonassen & Grabinger, 1989; Marchionini, 1988). Newby (1992) proposed a way to help orient the user, reducing the perceptions of disorientation: involve the user directly in the retrieval process. Newby's "navigable systems" open up the black box, taking the user "behind the scenes" instead of leaving them "in front of the curtain," waiting for the system to return results. According to Newby, easily navigable systems enable the user to directly engage in the retrieval process, which, in turn, reduces the level of disorientation.

Marchionini's (1993) techniques of zooming and browsing are similar to Newby's navigable system space. Like navigable systems, zooming and browsing involve the user directly in the retrieval process: the system zooms into a relevant area of the information space, offering several suggestions that may or may not be relevant to the learner's needs. After moving closer, the learner is better able to browse and select the desired information from what is available. The system does not supplant entirely the effort of the learner, but instead engages them directly in the process of determining relevance.

In some ways, Netscape® provides zooming and browsing capabilities for the World Wide Web. The learner submits a request, after which the search engine scans the Web information space and returns a list of "hits." At this point, the concepts of zooming and browsing break down in several important ways. A primary way that it breaks down is in what is returned. As currently structured, the listing of relevant documents can range from titles of the documents to http:// addresses to ftp sites. Obviously, this makes the list less intuitive and transparent.

One way to overcome this problem might be to standardize how the systems provide feedback to the learners. Several systems have already been developed, such as the standardized retrieval scheme developed by the Library of Congress, which has been tested and evaluated for several years. Standardized searching on the Web, adapting the LC retrieval model, might help to reduce disorientation.

Marchionini's (1993) techniques of zooming and browsing also lose validity in Netscape® in how information is ultimately presented to users. Zooming and browsing can invoke images of movement in a three-dimensional space. As Netscape® is currently designed, a space that may be perceived as three dimensional is flattened to two dimensions. The information space is represented on a flat screen without elements of depth.

This potential "warping" of the learner's mental model can be very disorienting, leading the learner to look for "clues" in the environment to re-orient themselves. Alyssa looked to a map to improve her orientation to the information available. This coincides with Forsyth's (1988) recommendation of a "multi-sensory" approach for facilitating memory -- as well as improving user orientation.

Several options are available, but the theoretical "best" option remains elusive. It is clear, however, that guidelines need to be established if we are to optimize use of emerging information systems (Jones, 1993). The establishment of guidelines, and maintenance within certain parameters, is crucial if learners are to establish useful mental models that assist them in their understanding (Norman, 1983). Until learners are able to engage in natural mapping of these information systems (Norman, 1988), and guidelines are established that ensure consistency and predictability (Wadlow, 1990), disorientation will persist.

Research Question Three: Does perceived self-efficacy affect the strategies employed?

Perceived self-efficacy affected both the number as well as the types of strategies which were engaged. Those who reported mid-to-high perceived self-efficacy (Bill, Marsha: mid; Mick: high) engaged in more strategies and at a higher level than Alyssa who reported low perceived self-efficacy. This is consistent with studies examining the relationship between self-efficacy and performance (Ashton, 1984; Kinzie & Delcourt, 1991; Murphy et al., 1988), where high positive correlations were reported between self-efficacy and performance.

Perceived self-efficacy not only affects the learner's interactions, but also perceptions of control. System interactions with Bill and Mick confirm this finding; both had higher levels of perceived self-efficacy and were successful in their task. Although Marsha was not successful in her target task, she was able to find useful information; her confidence and high perceived self-efficacy helped elicit this result. Alyssa, in contrast to the others, demonstrated lower perceived self-efficacy throughout. This, in turn, influenced her interactions and strategies, leaving her unsure of where she was or how to proceed, and unable to move beyond basic search strategies.

Research Question Four: Does system knowledge affect the strategies employed?

System knowledge also affects the strategies used in a hypermedia information system. Participants with low system knowledge engaged in more basic search strategies than those with higher system knowledge.

The level of system knowledge had a stronger influence on strategies used than subject knowledge. This is consistent with Park and Hannafin's (1992) conclusion that the lack of a functional mental model of the multimedia system tends to minimize the value of domain knowledge. While Alyssa possessed some domain knowledge, she had no prior system knowledge. The absence of a functional mental model, as well as an inability to establish one, resulted in very limited success in working with the system and an inability to move beyond basic search strategies. While increased system knowledge may not directly lead to success, system understanding is critical to selecting terms and knowing how to interact. Increased system knowledge can also reduce disorientation and frustration.

Closely related to a subject being searched is the intent behind what is sought in the system. The way that World Wide Web technologies are currently designed makes the environment one of "at your own risk." Anyone can place any kind of information on the Web. In addition, there is minimal structure to the documents. This leaves the user in a position where their intent may not match that of the document retrieved. A "best" solution for this issue remains unresolved.

The ability to use the system influenced the strategies the participants engaged. All participants entered the search task with no prior system knowledge directly related to Netscape®. While Mick reported using other hypertext systems, none had used Netscape® prior to its introduction in class. The two participants who built a functional model for the system, Bill and Mick, were also successful in their tasks and moved beyond basic search strategies.

Bill and Mick were also the only participants able to describe and depict their mental model of the system. Mayer's (1989) work on conceptual models provides an interesting interpretative background. Mayer found that in studies where conceptual models were provided, learners were able to make significant strides in problem solving and understanding. While participants in this study were not provided with a model prior to the search task, those who generated their own conceptual models engaged in strategies at a problem-solving level and increased their understanding.

Consistent with previous research, increased system experience and system knowledge seems to affect the strategies used in the system (Weil, Rosen, & Wugalter, 1990). The participants reinforced this observation through their interactions, and in the stimulated post-search interviews. All stated that, given more time and experience, they were confident that they would be better able to use the system.

Research Question Five: Does subject knowledge affect the strategies employed?

The level of subject knowledge affected the strategies used in the hypermedia information system. While the participants used a variety of strategies independent of their prior subject knowledge, those with lower subject knowledge engaged in more primary search strategies. These results assist in confirming what other researchers have found: learners with extensive context-related prior knowledge out-perform their cohorts with limited prior knowledge (Langer & Nicolish, 1981; Recht & Leslie, 1988). Osman's (1992) conclusion that the availability of content-related prior knowledge as a powerful determinant of retrieved information was also supported in this study.

The level of prior subject knowledge also affects the ability to integrate and retain new information (Ausubel, 1963). Bill, who possessed a higher level of subject knowledge, refined his search based on terms he previously tried. Marsha, who possessed little prior subject knowledge, refined her search little, using few terms to seek information. While the number of terms used during the search process was not a strong indicator of failure, it could be an indication of the inability to monitor and judge relevance in relation to information sought. According to Ausubel, the ability to integrate and transform information is a crucial component to performance. The lack of integration of the information the user receives while searching for information in Netscape® would cause conflict in relation to performance and search success.

RECOMMENDATIONS AND IMPLICATIONS

The implications for creating productive and successful OELEs are compelling. Several studies have been conducted indicating the promise of these systems (see, for example, Harmon, 1992). However, much work is needed to realize the potential of OELEs for learning.

One area that was a significant influence on the learner's successful use of the system was a feeling of insecurity or discomfort. Hannafin, Hall, Land and Hill (1994) discussed this as a significant issue affecting the use of OELEs. In the present study, the second most influential factor inhibiting use of the hypermedia information system was disorientation, which led to discomfort and confusion. The methods for overcoming disorientation and discomfort, as well as for assisting and supporting learners in their use of the systems, remains unresolved.

Another issue arising from this study relates to the design and development of OELEs. While computer and information scientists have developed design models for creating information systems, and instructional designers and psychologists have created design models for the development of learning systems, none seem to satisfactorily support the design and development of OELEs. It is an area rich with significant, but unfulfilled, promise.

The need for guidelines, both in terms of supporting the learner and in developing the systems, is also apparent. Guidelines for placing information on the Web and Internet, as well as indexing and providing pointers to this information, are not standardized. This lack of standardization makes the development of these systems challenging for the designer, and also presents significant challenges to users of the systems as they attempt to create a functional model (Norman, 1983) of the information system. While the researcher agrees with Jones (1993) that "hard and fast" rules are neither feasible nor desirable for these environments, guidelines are necessary if we hope to see the continued growth and utility of these environments.

A final implication relates to how individuals think. A fundamental problem underlying the lack of understanding associated with OELEs is the manner in which "compliant" thinking is shaped by conventional school activities (McCaslin & Good, 1992). Traditionally, education has been a lock-step, highly directed experience (Hannafin, Hall, Land, & Hill, 1994). This engenders learners who lack the orientation, mental models, and strategies (or capabilities for creating them) for these environments (Hill, Lebow, Driscoll, & Rowley, 1994), where divergent thinking, multiple perspectives, and independent thinking are critical.

While educational history was not gathered in the current study, there is evidence to suggest that those learners who developed an orientation and functional mental model of the system proved more successful in their task. These learners used two primary techniques associated with OELEs: divergent and independent thinking. Adjusting the ways we teach to foster divergent thinking and multiple perspectives may assist learners in using these environments effectively and with minimal disorientation.

As open-ended hypermedia information systems continue to grow, both in their capabilities and affordances, the need to understand how to support learners in their use of the systems becomes critical. The promise of hypermedia and OELEs has been widely heralded (see, for example, Bransford et al., 1986; Grabowski & Small, 1991; Marchionini, 1988; Hannafin, Hall, Land & Hill, 1994). Continued research in this area will enable the realization this promise.

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Title:

History in Educational Technology

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> Whether we like it or not we can never sever our links with the past complete with all its errors. It survives in accepted concepts, in the presentation of problems in everyday life, as well as the language and institutions that we employ. Concepts are not spontaneously created or generated but are determined by prior thought - (Ludwik Fleck, 1979, p. 9).

This paper reports on some of the theories and methods that could charaterize historical study in the field of educational technology. It will begin with a discussion of the importance of historical study. Then it willl provide background about the problems facing the uses of differing historical methods in the study of educational technology. A description of the major domains of historical study will follow. This description will include a deeper discussion of the domains of intellectual history, including arguments for the use of two specific methodologies in the study of the history of educational technology, the history of culture and the history of ideas.

Introduction

History can be viewed as an interaction. It can be the interaction between the empirical and the hermenuetical (the intent to understand), the interaction between science and art, the interaction between anaysis and expresion, or even the interaction between events and thoughts.

Many professionals seem to be interested in the history of the field in which they practice. Some are interested inknowing their intellectual heritage, others would merely like to have a sense of their professional roots.

History is often viewed as a sort of a body of information. In this view history is considered to be a compilation of data. It appeals to the need for factual content. This view is empirical.

But history can also viewed from its methodological and theoretical starting points. In this view history is guided by the methods and theories that are followed when historical studies are undertaken. This view can be thought of as affective because the attitudes and values of the investigator are believed to effect a study. This view is philosophical.

These two views of history do not, in fact could not, stand in isolation from each other. There is factual content in the philosophical view of history. And there are philosophical considerations in the empirical view of history, although most often these are assumed and therefore the resultant reports or studies are considered to be factual. It is the primary emphasis of each of these viewpoints that contributes to their different outlooks on history.

In a field such as educational technology where each person formulates her or his of view of what the field is, each person could have a correspondingly different view of what the field's history is. The existance of a plurality of histories is not itself problematic. The problem arises when large numbers of members of the field believe that only certain factual content is the limit of the study of the history of the field. A discussion of the theories and methods of historical study can identify the alternatives that individuals can adopt or adopt for their own specific needs.

Studying the history of educational technology should help to answer the questions like 'why do educational technologists think the way they do about educational technology?' and 'how has that way of thinking changed with time?'. Perhaps these questions appear to invite mere speculation but as historian George Boas stated, "the history of ideas tells us among other things how we got to think the way we do-and if that is not of importance one wonders what is" (Boas, 1969, p. 3).

Why study history?

History is strongly connected with the concept of change in two ways. First, the study of history helps to show how things have changed and helps to explain why they are the way they are at present. Second, history provides the understanding which is an essential component of reflective thought. The study of history can help maintain traditions, help individuals to stick to their roots, if the roots are valued strongly enough. But historical analysis may also provide more options. An historical understanding can help us to 'break out' of past patterns or shift emphases if it seems important to do so. History can greatly contribute to the conscious decisions that are made about change.

Robert Duffy (1988) argues that "history is critical in forging a civilized intellect" (p. 460). Duffy suggests that there are five "desirable experiences and habits of mind uniquely promoted" (p.460) when studying history; (1) perspective, (2) encounters in cultural literacy, (3) appreciation of relativism in a pluralistic world, (4) analytical and (5) skeptical habits of mind.

Duffy describes perspective as "the ability to see people, values, ideas, institutions, or events against a larger convas of antecedents, related situations and relevant princilples" (p.460). He argues that encounters in cultural literacy occur when the student's values and ideas confront "great ideas, compelling personalities, events, and value systems of the past (p.461). An awarenes of relativism arises when "students are emersed in other cultures at other times" (p.461). Analytical habits are improves when "contending theses are permitted to sift and arrange facts into differing explanations of the event, idea, or personality at issue" (p. 461). Skeptical habits involve students in the "need for data and information before comitting to a proposition" as well as "a quality of mind that can live with tentativeness where the data are suggestive but insufficient" (p.462).

Harry Helson (1972) argued that there were seven reasons for psychologists to study the history of psychology. Since much of the field of educational technology is so closely associated with psychology I felt that it might be instructive to include these here. These seven reasons included: (1) "the driving power of ideas" (p. 116), that ideas stir emotions and lead to action; (2) "that the scientific enterprise is more or less continuous" (p.116), that science builds on what came before (even if it were wrong or had to be changed); (3) "perspective in the field leads one to discount large claims" (p.116), that attempts have always been made to claim the singular importance of one particular method, approach, or device; (4) "outright mistakes may be avoided if one sees how they were made in the past" (p.116), that while history may not be cyclical, patterns do emerge and occasionally circumstances sometimes provide the opportunity to avoid repeting errors; (5) to locate examples for teaching and scholarship; (6) "the mere joy of reading historical accounts" (p.117), which emphasizes the aesthetic dimension of both reading scholarly works and the satisfaction included in the struggle of academic expression; and (7) "that success as a rule is not achieved immediately" (p.117) in scholarly thought.

The historiographical problem of educational technology

Continuing in our review of history in psychology, John Wettersten (1975) identified some fundemental historiography/ methodological/ theoretical considerations for relating the history of scientific psychology The considerations identified by Wettersten are also important to studies in the history of educational technology. This is particularly true when you consider how many educational technologists affiliate themselves with psychology. Wettersten identified two types of histories : (1) inductivist, which includes true theories, facts, the discoverers, and dates of discovery; and (2) conventionalist, which says that the theories that were modified to get to present theories should be included. Wettersten puts the fundemental problem of writing a history of scientific psychology this way:

> "Though historians of psychology have attempted to meet both the inductivist and conventionalist standards, a successful history of psychology cannot be written in this way. There is one crucial fact which forces historians of psychology (of either bent) into difficulties: that the history of psychology is, for the most part, a history of schools. The research produced by the schools does not fit inductivist or conventionalist standards because the theories of different schools contradict each other. Contradictory theories cannot be both true, or both be modified antecedents of any unified contemporary theory" (p.157).

To some extent, attempts to write a history of educational technology face this same dilemna. Although it is certainly true that the nuances of practice more readily allow for the merging of differing theory bases. But there are probably more interpretations of the basic theories in an applied field which further complicates the problem.

Wettersten identified five techniques which were used by historians of scientific psychology to mask their fundemental problem. These techniques "are used to avoid the discussions of controversies, mistakes ans problems, and this avoidance leads to a misleading picture of the history of scientific psychology" (pp.157-158). The five techniques are: (1) vague and uncritical praise of theories; (2) recognition of fact gathering regardless of the significance of the facts; (3) uncritical praise of methodological theory: (4) recognition of techniques regardless of the results they produce; and (5) discussion of careers.

"How can the history of psychology be portrayed as a steady development culminating in current theory when any portrayal of current theory is either incomplete or inconsistant?" (p.158). (because it does not account for criticism/failure). "There are two solutions to the problems of the incompatibility of contemporary theories: one may write the history of a single school, or one may seek to reconcile different schools and their histories" (p.159). (in either casecriticism and failure must be addressed).

"Historians of scientific psychology have intended to portray the steady growth of the application of the scientific method and the results of that application. This may be interpreted in two ways. On the one hand, one may protray (sp) the intellectual history of the solution to problems of explaining human behavior. On the other hand, one may relate the story of the growth of the influence and study of scientific psychology as a sociological phenomenon" (pp.170-171). This is analogous to the history of ideas and cultural history.

"The history of psychology consists for the most part of the development, conflict and decline of schools...(if critical history is avoided)...the actual problems, theories aims and mistakes of psychologists- the most important events to understand if one wants to understand the history of any intellectual tradition-are omitted or distorted" (p.171).

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Title:

Creating and Using Hypermedia for Student Recruitment

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Proposal Description

This project involves the development and production of compact disk-read only memory (CD-ROM) based interactive media for the recruitment of students into graduate education programs. It includes the incorporation of user interfaces and the appropriate hypermedia linking of digital video, 35mm stills, charts, audio and textual information into a CD-ROM format. Technical production, planned dissemination, and user feedback analysis are also addressed.

Description

Recruiting by colleges and universities today has become extremely competitive. To maintain a cutting edge, recruiters should to consider technologies beyond those that are paper-based only. While successful student enlistment in this modern day era is still accomplished using linear technology (mail outs of brochures, catalogs, letters, etc.) high-tech alternatives may further enhance established print formats and generate even greater success. The utilization of newer formats: the World Wide Web pages and gopher sites on the Internet, videotapes, and CD- ROM discs, are predicted will pave the way for new recruitment directions. Landoni and Catenazzi (1993) reported that there were many disadvantages resulting from the static and non-reactive nature of paper-based publications. These included:

- difficulty of updating the content,
- difficulty of locating information,
- absence of sound, animation and moving pictures,
- cost of dissemination,
- possibility of being easily damaged,
- difficulty of customizing information.

Hypermedia is the solution to all of the above described problems. It may prove to be a good alternative to the more traditional linear formats. Hypermedia may be a tool that can be successfully used for recruitment. Grice and Ridgway (1993) said that hypermedia use needs to be judged on the basis of how well it helps people do tasks. They recently stated that:

> …hypermedia is here today. We have assumed that hypermedia better supports the same tasks linear information supports. ... we need to ask whether the benefits of hypermedia are uniform, or whether there are some tasks to which hypermedia is better suited. This is an area where research would be valuable.

Cortinovis (1992) additionally supported the usage of the computer and its more creative aspects to develop multimedia:

> It is only in a later phase that the new technology begins to be creatively exploited: the computer is used to compose and read hypermedia documents. ...the computer is now being discovered as a "new" medium:...it can be multimedia, but most important of all, it is interactive.

Project

The objective of this CD -ROM project was to create a master and multiple copies for dissemination of information, to potential students who have indicated an interest in our graduate and certification programs. We combined pertinent information from the following sources:

- our graduate catalog,
- state education certification bulletins,
- parts of television scripts and footage used in recent departmental and College of Education productions,
- photographic stills, slides and computer generated animation
- portions of pre-recorded video taken from recent interviews that were conducted with current graduates, faculty, and administrators from various offices on campus.

The disk contains information about the following masters and doctoral programs offered by the Secondary and Higher Education (SHEd) Department:

- College Teaching,
- Community College Teaching,
- Secondary Education,
- Vocational Technical,
- Educational Microcomputing,
- Educational Media and Technology,

- and Library Science.

In addition to information on the various academic programs, information on other available and important services was provided. These included:

- university admissions
- graduate school policies and requirements
- availability of financial aid and loans
- a directory of SHEd faculty (including e-mail addresses)
- community demographics
- health and medical facilities,
- public schools and day care facilities
- public and private housing,
- community and area recreational opportunities,
- local banking and loan institutions
- shopping centers
- extra-curricular activities
- accreditation

Making a CD-ROM is a process that costs time and possibly money, but a CD can provide a powerful medium for the transmission of information, the operation of programs, or the storage of data. The huge capacity of CDs to accommodate massive amounts of data and large programs enables them to be used for the dissemination of educational programs in a way that no other medium can. The creation and production of CDs has previously been limited to agencies or companies which could afford the hardware to record or "burn" the CDs. Recent drops in the cost of CD recorders now brings the process of CD production closer to users at large. The issue of prohibitive time constraints for a CD project is diffused by combining the talents of a team in a joint venture, drawing on the special abilities of each of the team members. The process is straightforward, however, and can be done by one person from start to finish, if the scope of the project is carefully limited.

The Procedural Steps

The steps in the process, and suggested software and hardware needed to complete a CD project, are delineated below:

1. The first step in the process of creating a CD-ROM is creation of a flow-chart. The objectives of the project are translated into sections and sub-sections for the program. No attempt will be made here to define procedures for making a flow-chart. This will vary, according to project requirements and program parameters. Beyond the flow chart, creation of story-boards can be used to embellish and flesh out the program content (various sub-sections of the flow-chart).
2. The next step involves the collection of raw materials for the project. This includes still photos, CDs, videotapes, printed documents, and the like. These may be pre-fabricated, even commercial (as long as copyright limitations are honored), or they may be tailor-made by the CD author. Once you decide to make a CD and have completed a flow chart for the project, you must either find or create the components that will form the content of your program.
3. Still photos will probably be scanned into files. DeskScan or Omni-Page Pro can be used, along with an HP scanner or the equivalent. There are many other sources for pictures, of course, such as CDs, "digitized camera" shots, or the Internet. Once pictures have been scanned, they can be edited and altered in a paint program, such as Paint Shop Pro.
4. You may also have text that you want to include in the program (more than likely); an easy way to bring text into your program is by scanning. Scanning text can be done with WordScan or with such software as Omni-Page Pro. The "Acquire" feature in Word 6.0, also allows you to scan directly into a word processing text file.
5. Video utilizes large amounts of disk space in a hurry. It will need to be used judiciously, always with a view toward economical treatment of this medium. Video must first be captured. Digital Video Producer Capture (DVP) was used to digitize the video for the SHEd-CD project. We used a SVHS player to advance the video signal to the computer. You will need to check the specifics of your capture card as they vary. Some will accept multiple sources of video while others are more narrow in their input capabilities. The DVP program allows you to place your clips into AVI (video) files for manipulation within the CD program.
6. Once video has been captured, it must be edited. An excellent program for editing video/audio (motion) and stills, is Adobe Premiere 4.0. This software allows you to blend your clips in creative ways. It also provides transitions for scene changes. This is a powerful editing tool and is quite easy to use.

7. All of these components will need to be brought together into a meaningful arrangement, so that CD users will get the point or reach the objective of the CD. To create a user interface and add the components for your program, you will need authoring software...that is, unless you are proficient in and prefer to use programming language, such as C++. The SHEd-CD project was created in an excellent authoring program called Multimedia Toolbook (from Asymetrix Corp.). Learning to use Toolbook may take some time, but its ability to create a framework for an interactive CD project is just outstanding.
8. Finally, the CD must be recorded or "burned" on a blank disk. Surprisingly, CD recorders are now obtainable for around $1500, and will become even more affordable in the immediate future. It is equivalent to making a back-up cartridge tape, in terms of difficulty of use...i.e., it is NOT hard to do.

Since we have Pinnacle CD-R hardware and software available on campus, our initial time delays and costs were minimal. Blank CDs can be purchased for $10-15 each. After recording "one-off" disks, we conducted pilot tests to see how well they worked. We then revamped the materials where needed, and burned another one, until we were satisfied with the product. Kiosk like hyperlinks to various topics (via buttons and icons) were used as the primary method to access the menu driven information.

In order to determine whether the product was "attractive" to students, we tested it on graduate students from our campus. The responses have been exceptionally positive. Our plan is to replicate and distribute the disk via the traditional methods of recruitment. Because replication costs are dropping rapidly, they no longer pose a problem in terms of cost per disk. We found prices in the $1.60/disk range for 500 discs to be available and acceptable.

The SHEd-CD project is evidence that CD production is within the reach of many who may believe that such an achievement is best left with experts or professionals. You, too, can make a CD-ROM.

Hardware and Software

These programs assume the use of a Pentium processor, minimum 8 MB RAM, and--for CD-ROM creation--400 MB or more of hard drive space. Keep in mind that a CD can hold up to around 680 MB, which means that you may make your program that large (especially if you include a lot of video), in which case you will need a commensurate amount of hard drive space. The SHEd-CD project incorporated the use of the following software programs:

- Asymetrix Multimedia Toolbook 3.0 for Windows
- Digital Video Producer Capture
- Adobe Premiere 4.0
- Sound Blaster Audio
- Video for Windows
- Wave Form and MIDI sound
- Paint Shop Pro
- Desk Scan II
- Word Scan
- Word 6.0
- Pinnacle CD-R
- Morph
- Animation Works

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Title:

The Effects Of Matching Learner Preference For Instructional Method On Achievement And Attitude

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Background

Cooperative learning has been heavily investigated as an instructional method in the last few decades. Johnson and Johnson (1991) claim that when students learn cooperatively, they learn more, like school and each other more, have higher self-esteem, and have improved social skills. Slavin (1983) reported that cooperative learning has a positive effect on student self-esteem, liking of classes and classmates, time-on-task, cooperativeness and many other variables. Other researchers (Crooks, Klein, Jones, & Dwyer, 1994; Klein, Erchul, & Pridemore, 1994; Klein & Pridemore, 1992; Snyder & Sullivan, 1995) have found less success with cooperative learning in promoting greater student achievement and better attitudes.

Many advocates of cooperative learning point to benefits other than instructional effectiveness per se as being sufficient reason to use cooperative methods. Several researchers have found students who work cooperatively had better attitudes toward their group members and group work (Mevarech, Stern, & Levita, 1987), liked working with computers more (Johnson, Johnson, & Stanne, 1986), had higher goal orientation (Johnson, Johnson, & Stanne, 1985), were more satisfied with the instruction, and had higher continuing motivation (Klein & Pridemore, 1992) . Others (Klein, et al., 1994; Crooks, et al., 1994) have found that students have higher continuing motivation for computer-based instruction when working alone or that there were no differences in attitudes between students working cooperatively or individually (Mevarech, Silber, & Fine, 1991; Dalton, Hannafin, & Hooper, 1989). The mixed results from cooperative learning studies indicate that there is still much to be learned about cooperative learning.

Several researchers have suggested that personal characteristics and preferences of the learners may be an important factor in determining the effectiveness of cooperative learning. Chan (1981) and Klein and Pridemore (1992) have studied the relationship of need for affiliation to performance and attitudes under cooperative learning. Slavin (1983) indicated that a predisposition to cooperate may influence the occurrence of cooperative behaviors.

One approach that could conceivably influence the effects of cooperative learning is to match students' assessed preferences for cooperative and individual learning with the type of program they receive, either cooperative or individual. Freitag and Sullivan (1995) found that matching learners to their preferred amount of instruction increased achievement and produced more confidence and satisfaction with the instruction. Shute and Gluck (1995) reported that students who exhibited high exploratory behavior in an instructional program performed better in an inductive type program that matched their learning style, whereas those who exhibited low exploratory behavior performed better in a rule-based program that matched their learning style. It seems likely that matching students preferences for cooperative and individual learning with the type of program they receive could also maximize their potential performance.

The purpose of this study was to compare the effects of assigning students to a version of an instructional program (cooperative learning version or individual version) that either matched or did not match their pre-assessed preferences for cooperative and individual learning. Students' preferences for cooperative and individual learning were assessed two weeks prior to the instruction using a Learning Preference Survey created for this study. The study permitted investigation of the following research questions.

1. Do students achieve more when their preference for group work is matched with their instructional treatment than those who receive a contrasting treatment?
2. Does cooperative or individual learning yield higher achievement scores and better attitudes?
3. Does matching or not matching student preference for group work affect interaction patterns within cooperative dyads?

Method

Subjects were 135 students enrolled in an urban southwestern high school. Data from 104 students were used in the analyses. Scores from 31 subjects were discarded due to absences during the experiment. Subjects were blocked by preference for group work and then randomly assigned to an instructional method (cooperative or individual) which either matched their preference (matched) or did not match their preference (unmatched). Achievement was measured by a 36-item posttest referenced to the instructional objectives of the instructional program, and attitude was measured by a 12-item survey that assesses liking of the program, liking of cooperative learning, effort, and continuing motivation. Enroute behaviors were tracked by the computer, and student interactions recorded by trained observers.

All students were given instruction on how to work cooperatively and directions to facilitate cooperative learning were incorporated into the cooperative learning version of the instructional program. Each student was also given a Learning Preference Survey to determine their preference for group work. A median split was used to classify students as having a high or low preference. Students were then assigned to an instructional method (cooperative or individual) which either matched (matched) or did not match (unmatched) their preference in a 2 x 2 (matching condition x instructional method) posttest only experimental design.

Students spent approximately three 50-minute class periods working either individually or in pairs to complete a CAI lesson about basic geometry concepts such as lines, rays, angle, and polygons. Each lesson contained information, examples, exercises, review, and practice problems. After completing the CAI lesson, each student completed the posttest and the attitude survey individually.

A Pearson product-moment correlation coefficient was calculated to determine whether a significant relationship existed between preference for group work and student ability as measured by IOWA test scores for Reading. The Pearson correlation coefficient of -0.16, $p<.16$, revealed a non-significant relationship. Therefore, it was not deemed necessary to adjust posttest scores for difference in ability between students with a high preference for group work and students with a low preference for group work.

The posttest data were analyzed using an analysis of variance (ANOVA). A multivariate analysis of variance (MANOVA) was used to analyze the student attitude data, followed by univariate analyses for each question on the attitude survey. Time in program was recorded and analyzed using analysis of variance (ANOVA). Learning efficiency ratios were computed by dividing the each student's posttest score by the student's time in-program and were analyzed using analysis of variance (ANOVA). Differences in student in-program behaviors were analyzed using chi-square. All analyses were conducted at an alpha level of .05.

Results

The mean scores and standard deviations for achievement by preference and matching condition are shown in Table 1. Students in the unmatched conditions ($M = 21.77$) had higher significantly achievement scores than students in the matched conditions ($M = 19.15$), $F(1,100) = 5.04$, $p < .05$. The mean achievement score for students with a high preference for group work ($M = 20.50$) was only slightly higher than for students with a low preference ($M = 20.42$), a non-significant difference. The preference by matching condition interaction also was not significant. The overall mean achievement score was 20.46 or 57 percent.

The matching condition variable yielded an effect opposite to the predicted one -- that is, unmatched subjects scored significantly higher than matched ones, thus indicating that matching subjects to their preferred condition does not produce a positive achievement effect. Therefore, the decision was made to perform a second 2 x 2 analysis of variance for achievement using learner preference and the actual experimental treatments of cooperative and individual learning received by the subjects, rather than the experimenter-derived matched and unmatched conditions. Given the lack of positive predictive value of the matching variable, it was felt that analysis using the actual treatment conditions of cooperative and individual learning would be more useful for understanding and explaining the results than those using matching condition.

The preference (high, low) by program type (cooperative, individual) data are reported in Table 2. This analysis resulted in re-arrangement of the mean scores from two cells in Table 1 and, consequently, different ANOVA results. Subjects under cooperative learning had a mean score of 21.46, and those under individual learning had a mean of 19.46, a non-significant difference, $F(1,100) = 2.96$, $p < .09$. The mean scores for high-preference subjects ($M = 20.50$) and low-preference subjects ($M = 20.42$) remained the same as in the initial ANOVA, of course, and did not differ significantly from one another. However, the preference by program type interaction was statistically significant, $F(1,100) = 5.04$, $p < .05$.

The significant preference by program type interaction reflected the fact that students with a low preference for group work scored higher ($M = 22.73$) when they worked cooperatively than when they worked individually ($M = 18.11$), whereas students with a high preference for group work scored slightly lower when working cooperatively ($M = 20.19$) than when working individually ($M = 20.81$). Tukey's post hoc method for pairwise comparisons revealed that the achievement score of 22.73 for the students in the low preference-cooperative condition was significantly higher than the achievement score of 18.11 for the students in the low preference-individual condition at the .05 level. All other pairwise comparisons were not significant.

Table 3 shows the mean times in program by preference and program. Students with a high preference for group work averaged 101.45 minutes to complete the program, and those with a low preference for group work averaged 80.35 minutes, a significant difference, $F(1,58) = 9.63$, $p < .01$. Students in the cooperative dyads averaged 84.06 minutes in the program, and students working alone averaged 95.94 minutes, a nonsignificant difference.

The groups with higher, though not significantly higher, posttest scores for each variable (low-preference over high-preference, cooperative over individual) also spent less time in the program than their counterparts. Therefore, learning efficiency ratios (LERs) were computed for each student and group to determine whether there were significant between-group differences in learning efficiency -- i.e., the amount learned, as measured by posttest scores, per unit of time. Each student's LER was calculated by dividing his or her posttest score by his or her time in program. For example, a student with a posttest score of 20 and a time in program of 80 minutes would have a learning efficiency ratio of .25 (20 ÷ 80). Table 4 shows the mean learning efficiency ratios by preference and program type.

The learning efficiency ratio data in Tables 4 reveal that students with a low preference for group work (LER $\underline{M} = .30$) had significantly higher LERs than students with a high preference for group work (LER $\underline{M} = .22$), $\underline{F}(1,79) = 7.81$, $\underline{p} < .01$. Students in the cooperative treatment (LER $\underline{M} = .29$) had significantly higher LERs than those in the individual treatment (LER $\underline{M} = .22$), $\underline{F}(1,79) = 7.83$, $\underline{p} < .01$. The preference by program type interaction for learning efficiency ratios was not statistically significant.

The responses to a 12-item attitude questionnaire administered at the end of the program were scored on a four point scale from 1 (strongly agree) to 4 (strongly disagree). MANOVA revealed a significant difference for program type, $\underline{F}(12,83) = 4.23$, $\underline{p} < .001$, but not for preference or the preference by program type interaction. Therefore, item-by-item univariate analyses were performed only for program type. The univariate analyses for program type revealed significant differences for three statements. Students working alone agreed significantly more strongly than students working cooperatively with the statement "I would like to learn more about geometry", $\underline{F}(1,94) = 7.63$, $\underline{p} < .01$. Students who worked cooperatively agreed more strongly with the statement "I would like to learn new math concepts with a group", $\underline{F}(1,94) = 7.46$, $\underline{p} < .01$, than students who worked individually agreed with the statement "I like to learn new math concepts by myself". Similarly, students who worked cooperatively agreed more strongly with the statement "I liked working in groups", $\underline{F}(1,94) = 18.31$, $\underline{p} < .001$, than the students who worked individually agreed with the statement "I liked working alone".

Chi-square was used to analyze number of observer-recorded cooperative interactions for differences between groups. The high-preference cooperative dyads had more instances of each of the four cooperative behaviors and of off-task behaviors than the low-preference pairs. These differences were significant for "asks questions" (99 instances for high-preference subjects and 69 for low-preference subjects), "discussion of lesson content" (203 instances for high-preference and 150 for low-preference), and "shares mouse or keyboard" (17 instances for high-preference and 2 for low-preference), and for off-task behaviors (220 for high-preference subjects and 94 for low-preference subjects).

Discussion

The present study examined the effect of matching student preference for group work with the instructional treatment that students received. Students with a high preference for group work were assigned to work either cooperatively (matched) or individually (unmatched), and conversely, students with a low preference for group work were assigned similarly (cooperatively = unmatched and individually = matched).

It was expected that students whose preferences for group work were matched, rather than unmatched, with instructional treatment would score higher on the posttest. In fact, when students were assigned to an instructional treatment which did not match their preference, they did better. Thus, a preference for group work did not predict better performance under group work. Rather, the data on interactions and off-task behaviors suggest that it is a predictor of desire to interact with others or sociability. Students with a high preference for group work who worked cooperatively exhibited significantly more off-task behaviors, such as talking to their partner or members of other groups about topics unrelated to the computer program, than those with a low preference for group work who worked cooperatively.

The analysis of the time spent in the program also seems to support the idea that the preference for group work measure was more a predictor of sociability than of performance. Students with a low preference for group work, in fact, spent less time in the program than their high-preference counterparts with no significant difference in performance. The smaller amount of time spent completing the program and the fewer number of off-task behaviors for the low-preference groups may indicate a learning approach that is more effective because it is more focused on the learning content and less subject to interference factors resulting from the off-task behaviors.

There is also considerable evidence that students may often prefer an instructional method that does not yield greater achievement. Peterson and Janicki (1979) found that elementary students who expressed a preference for small-group or large-group work had higher retention scores when they received the instructional method that was opposite their preference. Shute and Gluck (1995) found that if students had been assigned to treatments by their stated preference for exploratory behavior, no significant difference in achievement would have occurred between those who were matched to their preference and those who were not. Similarly, Hannafin (1994) found that students who indicated a preference for a lean instructional program had better achievement scores when they were not matched to their preference.

There is a common belief in educational technology, as well as in other areas of education, that students are good judges of the ways they will learn best. This belief was an important factor in the design of the present study. In retrospect, however, it is important to examine why this may not be the case. Students may not be able to readily identify methods which will increase their achievement on school tasks or they may not care much about relatively minor improvements in achievement. Their preferences may be stronger for methods which they think will require less work, be more fun, allow for more social interaction, or give them more freedom of choice.

Although the cooperative students had higher posttest scores, they did not differ significantly from the scores of the students who worked alone. Several factors may account for the fact that cooperative learning did not have a stronger effect. A number of recent studies have shown that cooperative learning may not be as powerful an instructional method as previously thought. Snyder and Sullivan (1995) and Klein et al. (1994) found that students learning alone outscored students who worked cooperatively. Crooks, et al. (1994), Crooks (1995), and Doran (1994) did not find significant differences in achievement between students who worked cooperatively and those who worked alone. With the exception of Snyder and Sullivan (1995), all of the above research was conducted with college students. It may be that older students do not benefit from cooperative learning as much as younger ones. Most of the research which has shown achievement differences in favor of cooperative learning (Johnson et al., 1985, 1986; Slavin, 1983) has been conducted with younger students.

Cooperative learning advocates often attribute the lack of a significant difference favoring cooperative learning to the students not being sufficiently accustomed to working together to benefit from the cooperative learning situation and/or the fact that cooperative learning conditions do not include Johnson and Johnson's (1991) five key elements. These elements are positive interdependence, face-to-face interaction, individual accountability and personal responsibility, interpersonal and small group skills, and group processing. While these explanations may often be true, it also is often true that learners do not have good skills for studying individually and that the best conditions for learning often are not incorporated into individual learning treatments. In the present study positive interdependence, individual accountability and personal responsibility were intended to be fostered by having students take the test individually and receive extra points on the test if the average of the test scores of the partners was above a certain level. The incentive of a good test grade may have not been a sufficient motivator to encourage the students to work together. Most students seemed more inclined just to get through the program than to learn the material well.

The present results raise the possibility that students' "sociability" may influence the effectiveness and efficiency of cooperative learning as an instructional treatment for them. Research that investigates the relationship between a measure of sociability and achievement under cooperative learning could indicate the extent to which sociability impairs or facilitates student learning in cooperative groups and may have implications for group composition in cooperative learning situations. Research of this type may help us better understand the conditions under which cooperative learning is most effective in the schools.

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Table 1

Mean Posttest Scores by Preference and Matching Condition

	Preference		
Matching Condition	High	Low	Totals
Matched	20.19 (6.40)	18.11 (5.90)	19.15 (6.18)
Unmatched	20.81 (5.96)	22.73 (5.45)	21.77 (5.74)
Totals	20.50 (6.13)	20.42 (6.09)	20.46 (6.08)

Table 2

Mean Posttest Scores by Preference and Program Type

	Preference		
Program Type	High	Low	Totals
Cooperative	20.19 (6.40)	22.73 (5.45)	21.46 (6.02)
Individual	20.81 (5.96)	18.11 (5.90)	19.46 (6.03)
Totals	20.50 (6.13)	20.42 (6.09)	20.46 (6.08)

Table 3

Mean Total Time in Minutes by Preference and Program Type

	Preference		
Program Type	High	Low	Totals
Cooperative	98.27 (33.57)	68.43 (18.67)	84.06 (30.88)
Individual	102.96 (24.46)	86.98 (30.73)	95.94 (28.19)
Totals	101.45 (27.30)	80.35 (28.16)	91.92 (29.43)

Table 4

Mean Learning Efficiency Ratio by Preference and Program Type

	Preference		
Program Type	High	Low	Totals
Cooperative	0.24 (0.14)	0.35 (0.12)	0.29 (0.15)
Individual	0.21 (0.08)	0.24 (0.11)	0.22 (0.09)
Totals	0.22 (0.11)	0.30 (0.13)	0.26 (0.13)

Title:

Scaffolding in Hypermedia Assisted Instruction: An Example of Integration

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ABSTRACT

To prevent the user from the over-relying on technology support, we propose a 3-D contingent scaffolding model to systematically vary the instructor's support in response to the learner's performance in a learning task consisting of a sequence of steps/sub-tasks. We report on the implementation of this model in a computer-based instruction program here and on a study of its effectiveness. In this study, the 3-D contingent scaffolding model is implemented in a computer-based instruction program, "Hypothesis Testing-- the Z-Test" in order to establish baseline data for integrated-media-based instruction or hypermedia based learning environment. Our findings show evidence that "Hypothesis Testing-- the Z-Test" does indeed promote knowledge maintenance and improve independent learning.

INTRODUCTION

The term "Scaffolding" has been used to describe various instructional techniques for use in learning activities that reflect authentic task situations. This technique has also drawn great attention from the media researchers for media can provide a more realistic learning environment with rich and varied support. One major concept of this technique is to enable the learner to engage in out-of-reach activities; having a "knowledgeable other" or "more capable peer" to bring the learner along; having something or someone "share the cognitive load" (Jackson et al., 1995). However, if we go back to Bruner's original definition of scaffolding (Bruner, 1983), we find there is another valuable key concept of this technique that has usually been neglected. That is, this knowledgeable or more capable other is not only responsible for building the support in learning activities, but also is responsible for fading the support as the learner gradually masters the skill. The Cognition and Technology Group at Vanderbilt University (1993) has proposed a risk of over relying on the support of integrated media. To educate individuals to be independent and active learners, there is a need to emphasize the support-fading component of scaffolding while we try to integrate this instructional technique into any kind of media assisted instruction.

BACKGROUND

Method of Scaffolding

In the past 20 years, the constructivist paradigm has gradually come to educational research. From the constructivism perspective, the purpose of education is to cultivate independent and self-directed learners. Bruner's metaphor of scaffolding provides an explicit strategy to direct our teaching toward this end.

Scaffolding refers to the interactional support that instructors or more skillful peers offer learners to bridge the gap between their current skill levels and a desired skill level. In the process, the amount of support is gradually withdrawn as the learners become more proficient. Ultimately, the learners can complete tasks on their own (Greenfield, 1984). The literature review suggests that scaffolding can enhance comprehension, improve independent learning, and promote knowledge transfer (Bruner, 1983, Greenfield, 1984, Cazden, 1988). Evidence of these advantages has been found in many studies in the field of language and cognitive development (Gallimore et al., 1989; Boyle and Peregoy, 1990; Day and Cordon, 1993).

At the same time, limitations of scaffolding have also been pointed out. This technique has been criticized for its lack of discussion on development of the expert's role in providing the novice with assistance (Gaffney and Anderson, 1991). Its implementation has also been criticized for not being able to capture the challenge of responding to the diversity of children's intentions in classroom teaching (Dyson, 1990).

Scaffolding in Media-Based Instruction

Computers have introduced unprecedented levels of autonomy into education. The processing and integrating capabilities of computers have created an interactive, support-rich, and individualized learning environment. These characteristics might break the limitations of scaffolding and ease the implementation of this instructional technique.

Several researchers have developed scaffolded computer-based instruction, integrating more than one medium to support learners' knowledge construction in authentic learning activities (Steiner & Moher, 1994; Jackson et al., 1995). However, the discussion has been focused on the software development and the support-building models. Only a small amount of qualitative evaluation data have been reported. The support-fading element of scaffolding was not applied in these studies. Therefore, solid scaffolded instruction is not only difficult to built, but also extremely difficult to evaluate.

Leiberman and Linn (1991) contented that scaffolding is one of the several ways computers can be used to encourage students to be self-directed. This should be attributed to the support-fading skill used in the scaffolding. However, to use this skill, the major challenge will be when the support should be faded and how much the support should be reduced at the time. This requires us to find out another technique allowing us to know the learner's mastery level at any point of the scaffolded learning process.

LINKING THE CONCEPT OF SCAFFOLDING TO INTEGRATED-MEDIA DESIGN FEATURES

In this session, we sought for an operational definition of scaffolding. Based on the definition, we proposed a 3-D scaffolding model which provides a systematic way to apply scaffolding in integrated-media based instruction.

The Elements of Scaffolding Relevant to Integrated Media Design

To link the concept of scaffolding to the integrated-media design features, it is important to identify some basic elements of scaffolded instruction which are especially relevant to the integrated-media design. To illustrate the features of those elements, the metaphor of an adult aiding a toddler (Cazden, 1988) will be used as an example.

1. Hierarchical component skills

   In the metaphor of scaffolding, the acquisition of skill is conceived as a hierarchical program in which component skills are combined into "higher skills" by appropriate orchestration to meet new, more complex task requirements (Bruner, 1973). Therefore, the crucial task in scaffolding often possesses a variety of relevant components (usually in an appropriate serial order) necessary to achieve a particular end. And that is the instructor's responsibility to decompose the final task into hierarchical component skills based on the nature of the task and the learner's ability. In the example of an adult aiding a toddler, the child must learn how to balance on his feet before taking his first step, must learn how to balance on his first step before stretching out for the second.

2. Decreasing support levels

   Scaffolding emphasizes the support that the instructor can provide the learner to reach beyond his/her current skill level. The highest level of support is the situation where the instructor completes the task as a demonstration and the learner takes no responsibility for the current task. The lowest level of support is the situation where the instructor takes no responsibility for the task and the learner completes the task on his/her own. Between the highest and lowest level of support, the instructor shifts a part of the responsibility to the learner by reducing the amount of support one level at a time. In the sense of support withdrawn, the instructor must recognize what kind of support is crucial in the learning and classify the support into decreasing levels. In the example of an adult aiding a toddler, the levels of support could be: helping by holding two hands, helping by holding one hand, helping by holding one finger, etc.

3. Repetitive authentic practice

   The scaffolding should be performed in the social context of the practical work environment. In the environment, the learner can practice by taking part in the expert behavior in a realistic setting. Each practice involves a full performance of the task. Besides, the underlying structure of the practice must be repetitive so the experience at one point in task mastery could potentially be applied to later activity. Therefore, the instructor has to set up a sequence of authentic practice involving the performance of the same skills. In the walking example, the child actually experienced the practical task, walking. The practice of walking involves the same component skills and the practice can be repeated in different realistic settings: walking on the carpet, walk on the solid ground, walk on the sand, etc.

4. Ongoing assessment

In the process of scaffolding, the support level should be adjusted based on the learner's current skill level. Therefore, the instructor must measure the learner's progress against the global picture of the task and make corrections when needed. Usually, the completion of each component skill is the right time for a progress assessment. In the walking example, the adult observes and measures the child's progress with each baby step. If holding one hand of the child doesn't keep his balance, the adult gives him the other hand right away. If the child walks well by holding one hand, the adult will consider letting him walk by holding only one finger.

Therefore, an operational definition of scaffolding could be as follows. The instructor or the more skillful peer decomposes the task into hierarchical sub-tasks, classifies the amount of support in decreasing levels, and sets up a repetitive authentic practice. The practice begins with the highest level of support and the lowest level of sub-task. With the completion of each sub-task in the practice, the instructor measures the learner's performance and judges the level of support he/she should provide and lets the learner perfect the component sub-task that he/she can manage.

The Three-Dimension Contingent Scaffolding Model

Wood et al. (1976) and Day and Cordon (1993)'s studies have suggested the "contingent scaffolded instruction", emphasizing the addition of a pattern of responses for the withdrawal of the support. The pattern involves characterizing the instructor's intervention by the level of abstractness and varying those levels systematically in response to the learner's performance. Based on the first two elements of scaffolding discussed above, there are two types of intervention that the instructor can provide in a scaffolded instruction. The first type involves the control of the task complexity by simplifying the task itself. The second type involves the control of the task complexity by providing the additional support. Most studies have focused on the second type of intervention, the additional support. The 3-D model proposed in this session adapted the contingent scaffolded instruction to systematically vary the instructor's support in response to the learner's performance in a learning task consisting of a sequence of steps/sub-tasks.

The first two elements of scaffolding actually divide the learning task into N learning situations. Here N indicates the number of possible combinations of support level and sub-task level. For example, if the target task contains 4 hierarchical sub-tasks and 4 levels of support, there will be 16 different possible learning situation that the learner might encounter at the time depending on the learner's current skill level (see the following figure).

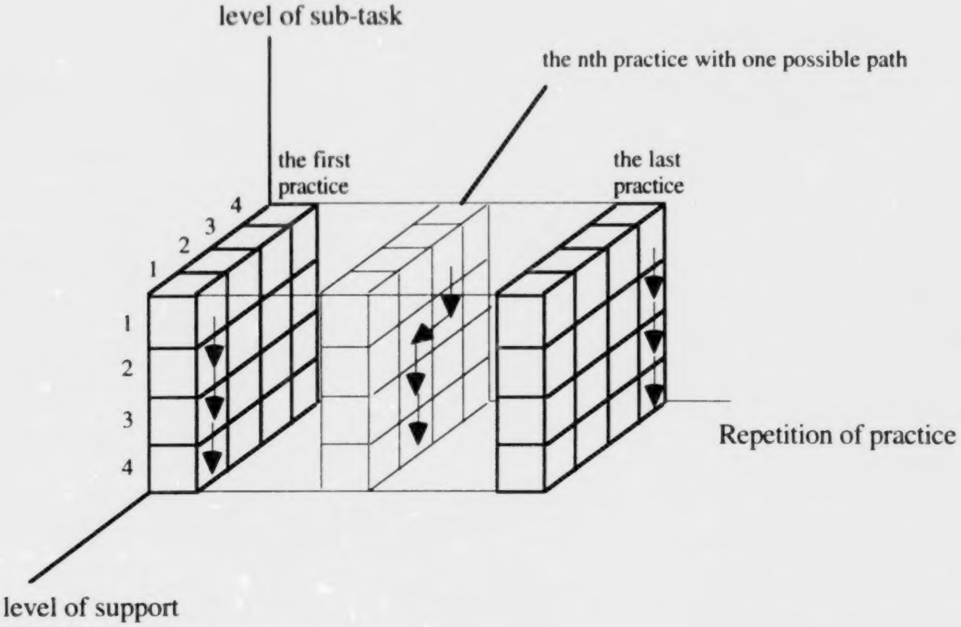
	Support Level 1	Support Level 2	Support Level 3	Support Level 4
Sub-Task 1				
Sub-Task 2				
Sub-Task 3				
Sub-Task 4				

The support levels range from level 1, the least independent and most concrete level (at which the instructor assumes all of the responsibility for the performance) to level 4, the most independent and abstract level (where the learner has assumed most of the responsibility). The sub-tasks range from 1 to 4 representing a sequence of acts which must be completed in this sequence in order to complete the target task. The process of scaffolding starts with the completion of the full task (from sub-task 1 to sub-task 4) at support level 1 and ends with the completion of the full task at support level 4 through a sequence of repetitive authentic practices, the third element of scaffolding. The whole process of scaffolding is performed according to the following rules.

1. Each practice involves a full performance of sub-tasks from the first to the last.
2. The first practice starts with the highest level of support. After that, each practice starts with the level of support which is one level lower than the latest one used in the previous practice.
3. At the current level of support, the learner has the chance to work on the following sub-tasks unless he/she encounters any difficulty.
4. In each sub-task of the practice, if the learner encounters any difficulty, the support level is increased by one until reaching the highest level.

The fourth element of scaffolding, ongoing assessment, is actually embedded in the rule 4. To see if the learner encounters any difficulty, an ongoing assessment must be performed at the end of each sub-task.

This model of scaffolding describes the learning process as a journey in the space of the three dimensions: level of sub-task, level of support, and number of the repetition of the practice (see the following figure). The first practice is presented as an example in which the instructor takes full responsibility for the task (full support is provided). The last practice is a completely successful examination where the learner takes the full responsibility of the task (the least support is provided). Any practice in between either is an unsuccessful performance or a successful performance but with some level of support. Along the path of the journey, each cubic block is a unit of assessment of the learner's progress. Since this model applies scaffolding in a systematic way, it is especially useful for the computer or integrated media based instruction.



AN EXAMPLE OF IMPLEMENTATION: "HYPOTHESIS TESTING-- THE Z-TEST"

Based on the 3-D model, the software, "Hypothesis Testing-- the Z-test", was developed. In this section, we describe the program of "Hypothesis Testing-- the Z-test", and explain how the 3-D scaffolding model was implemented in this program.

The Motivation of the Task

Statistics is interesting and useful because it is a mean of using data to gain insight into real-world problems. However, almost every statistics beginner experiences difficulties understanding the topic. Almost every statistics instructor admits that it is not an easy subject to teach.

As the continuing revolution in computing relieves the burden of calculating and graphing, there is an emerging consensus among statisticians that statistical education should focus on data and on statistical reasoning rather than on either the presentation of as many methods as possible or the mathematical theory of inference (Moore and McCabe, 1993). This consensus has the following influence on statistical education.

1. Applied Statistics should be taught in the context of real-world problems.
   Statistics takes real life patterns in real life phenomena and tests them quantitatively. Bridging that gap between reality and numbers is the hardest part. Not all numbers are data. The number 10.3 acquires meaning only when we are told that it is the birth weight of a child in pounds or the percent of teenagers who are unemployed. That is the context that makes the numbers meaningful. Therefore, the examples and exercises should be presented in the context of real-world problems.

2. Applied Statistics can be taught to an extremely diversified audience.
   Because the statistics is useful for scientific investigators in many fields, the students sitting in a introduction course of applied statistics might have varied background in Agriculture, Biology, Chemistry, Computer Sciences, Education, Engineering, Genetics, Home Economics, Industrial Management, Mathematics, Medicine, Pharmacy, Social Sciences, Statistics and Veterinary Science. However, if the student has no fear of statistics, wants to learn and possesses a certain amount of mathematical maturity, the varied backgrounds need not detract from the success of the course. In fact, many times this diversity may make students recognize similarities among problems from different fields of application. This gives them a broader scientific approach to statistical problems than providing them only with familiar examples.

3. Applied Statistics can be taught at a low mathematical level.
   Since it is the statistical reasoning that should be focused upon instead of the statistical computation, even students with low mathematical level can learn statistics. Therefore, the students of applied statistics can range in mathematical competence from Ph.D. candidates in mathematics to students who had only high school algebra. Actually, the learners need only a working knowledge of algebra. Being able to read and use formulas would be enough.

4. Applied Statistics can be taught through the applications of a set or a sequence of rules.
   Applied Statistics is actually the application of a sequence of rules or principles which is set up based on certain mathematical proofs or the experience of prior statistical experts. The learners do not have to understand the mathematical proof behind each rule. However, it is important for them to understand the expert reasoning behind those rules. It is not only logical but also conceptual. To understand the statistical reasoning, the learner has to work and communicate with the expert to carry out the rules in realistic problems.

Based on the above discussions, we decided to develop a scaffolded computer based instruction in the context of teaching basic applied statistics. The very basic test of statistic hypothesis testing-- the Z-test was selected. The task was selected with several objectives in mind. First, it had to be challenging to the learner while also proving sufficiently complex to ensure that his/her comprehension and problem-solving skill over time could develop. Second, it had to be "feature rich" in the sense of possessing a variety of relevant components. Third, its underlying structure had to be repetitive so the experience at one point in task mastery could potentially be applied to later activity.

This subject matter involves a sequence of problem solving steps and decision making. It naturally provides the chance for assessing users' ongoing learning as well as scaffolding through program support. Therefore, the program instruction is presented as a series of problems involving applying the Z-test.

Implementing the 3-D Contingent Scaffolding Model in "Hypothesis Testing-- the Z-Test"

The following table summarizes the four elements of the scaffolding model and briefly describes how each is implemented.

Elements of Scaffolding and "Hypothesis Testing-- the Z-Test" CAI Design Features

Elements of Scaffolding	CAI Design Features
1. Hierarchical component skills	Four serial steps to carry out the Z-test
2. Decreasing support levels	Four levels of support
3. Repetitive authentic practice	Up to 20 authentic problem scenarios
4. Ongoing assessment	Performance is judged at the end of each step

1. Hierarchical component skills

The common practice of hypothesis testing includes of the following steps.

a. State the hypotheses;
b. Find the critical value;
c. Compute the test statistic; and
d. Make the decision.

Based on the four steps, the program decomposes the task into four sub-tasks, allowing the learner concentrate all his/her effort on one sub-task at a time.

2. Decreasing support levels

In considering the support which can be provided via integrated-media and the nature of the task, three types of support were selected to be used in the scaffolded instruction. From concrete to abstract, the three types of support are:

a. Visual Support

This is a graphic illustration of the problem situation. Usually, the graph consists of one or two bell-shape curves, representing the sampling distribution(s) involved in the current step situation. This kind of graphic illustration has been used extensively in the statistics textbooks and statistics classrooms when the topic of hypothesis testing is first introduced. Most of the statistics teachers and learners believe this kind of visual support may facilitate statistical reasoning. In this program, this kind of graphic illustration was used as a visual hint to the answer of the current problem step.

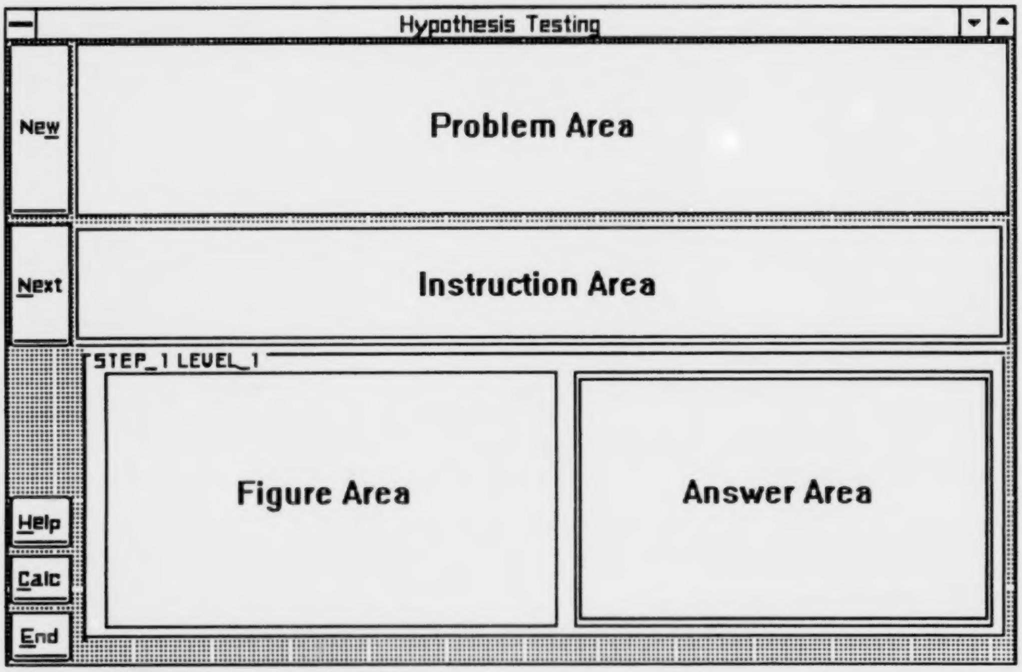
b. Verbal Support

This type of support includes the text instruction and leading questions or hints shown on the screen. While the answer of the current step is provided by the computer tutor, the verbal support is an explanation of the answer. While the answer should be provided by the learner, the verbal support is a hint and leading question of the answer of the current problem step. For example, "The first step of the hypothesis testing is to state the Null and Alternative Hypotheses. What hypotheses can you state for this problem?"

c. Symbolic Support

This type of support could be a specific Greek/English letter with a pre-defined meaning or a mathematical symbol for operations. Having the statistical reasoning, the practice of statistics can always be represented by formula, symbols, and numbers. The four steps of the hypothesis testing can also be represented in symbols. In practice, the symbolic support took the form of a symbolic prompt, requesting the learner to provide the answer of the current problem step. For example, "Z_a =" prompts the learner to find the critical value of the test statistic Z using the given level of significance a.

The program was developed using Visual BASIC 3.0 for the Windows environment. The actual environment of the lesson is displayed in the following figure. It explains how the visual, verbal, and symbolic support show on the program screen.



The environment of the lesson.

1. Problem Area
   The Problem Area shows the current problem scenario that the student is working on.

2. Instruction Area
   The Instruction Area provides the instruction or hints to solve the current step of the problem. It counts as the verbal support.

3. Figure Area
   The Figure Area illustrates the current step situation of the problem in a graphic form based on the learner's selection of the answers. That is where the visual support takes place.

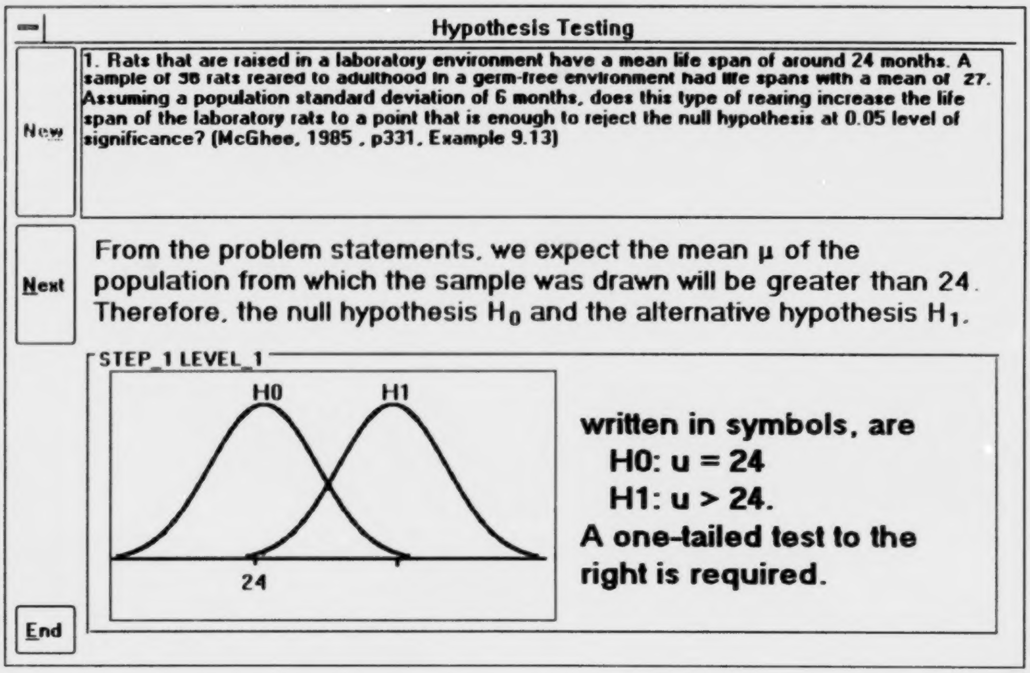
4. Answer Area
   The Answer Area provides the answer or requests the learner to provide answer for the current step after the symbolic support.

Levels of Program Support

Based on the three types of support described above, the levels of support can be classified and ranked by the amount of support (how many types of support) provided at the time. These are described below. From level 1 to level 4, the next most concrete type of support is withdrawn from the previous level of support.

Level 1: *Full Support*

The instruction demonstrates the steps to solve the problem in detail with visual, verbal, and symbolic information. The following is an example of the full support screen.



Hypothesis Testing

1. Rats that are raised in a laboratory environment have a mean life span of around 24 months. A sample of 36 rats reared to adulthood in a germ-free environment had life spans with a mean of 27. Assuming a population standard deviation of 6 months, does this type of rearing increase the life span of the laboratory rats to a point that is enough to reject the null hypothesis at 0.05 level of significance? (McGhee, 1985 , p331, Example 9.13)

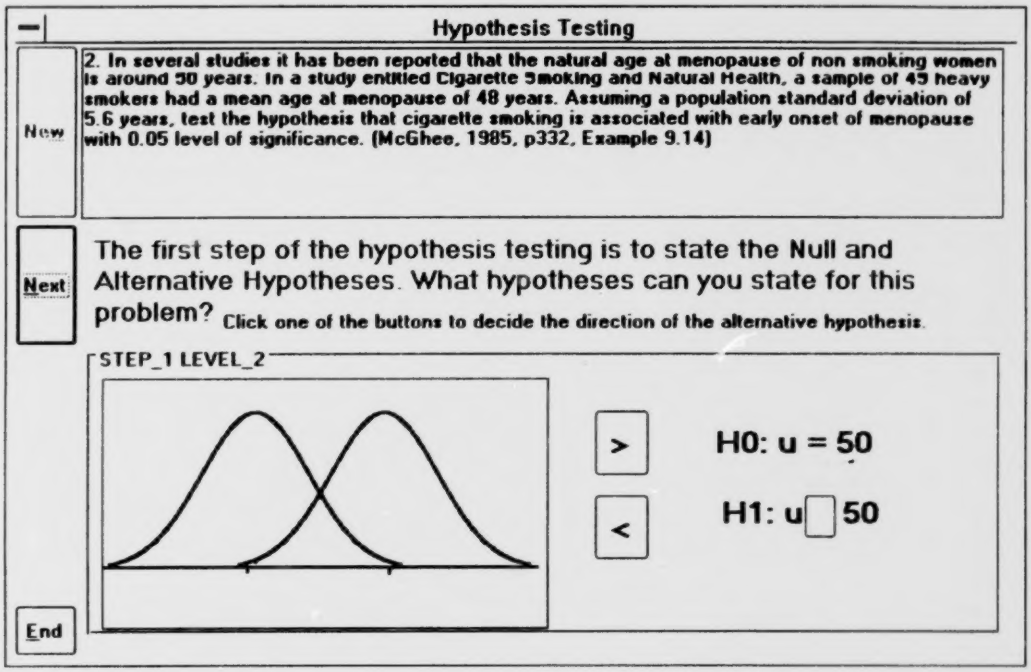
From the problem statements, we expect the mean μ of the population from which the sample was drawn will be greater than 24. Therefore, the null hypothesis H_0 and the alternative hypothesis H_1,

STEP_1 LEVEL_1

written in symbols, are
H0: u = 24
H1: u > 24.
A one-tailed test to the right is required.

Level 2: *Visual, Verbal, and Symbolic Support*

Instead of providing the answer with detailed explanation, the instruction only provide the visual and verbal hints to the current problem step and requests the learner to give the answer after the symbolic prompts. An example of the screen with level 2 support is provided in the following figure.



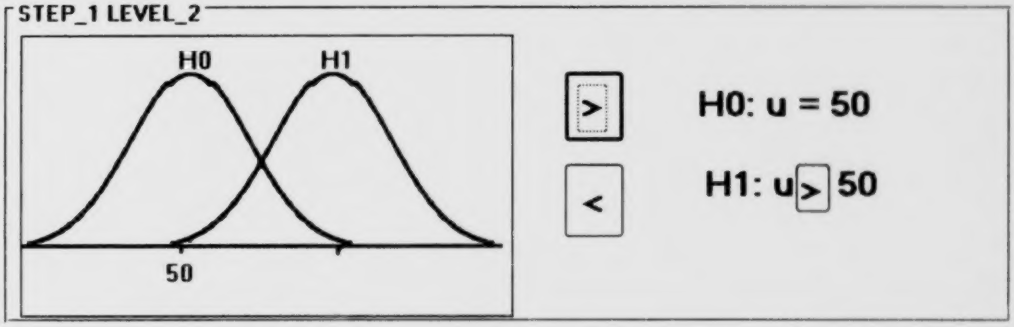
2. In several studies it has been reported that the natural age at menopause of non smoking women is around 50 years. In a study entitled Cigarette Smoking and Natural Health, a sample of 45 heavy smokers had a mean age at menopause of 48 years. Assuming a population standard deviation of 5.6 years, test the hypothesis that cigarette smoking is associated with early onset of menopause with 0.05 level of significance. (McGhee, 1985, p332, Example 9.14)

The first step of the hypothesis testing is to state the Null and Alternative Hypotheses. What hypotheses can you state for this problem? Click one of the buttons to decide the direction of the alternative hypothesis.

H0: u = 50

H1: u ☐ 50

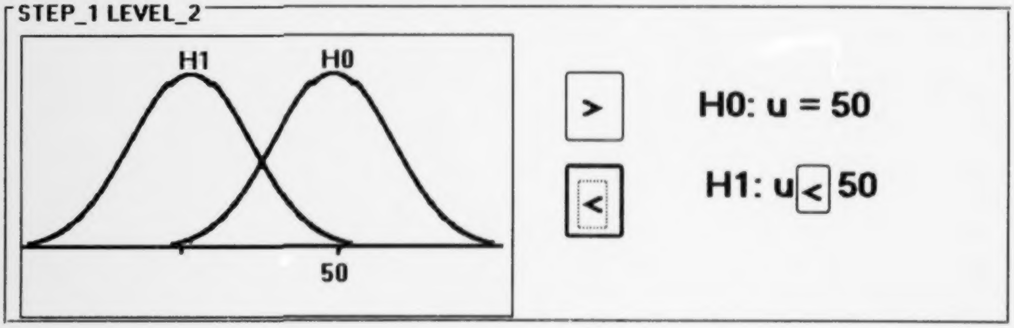
The Figure Area in the example is an initial form of the graphic illustration of the current step, Step 1. Based on the learner's selection of the answers, more information will be added to the graph. The following figure shows the result if the ">" is selected in the answer area.



H0: u = 50

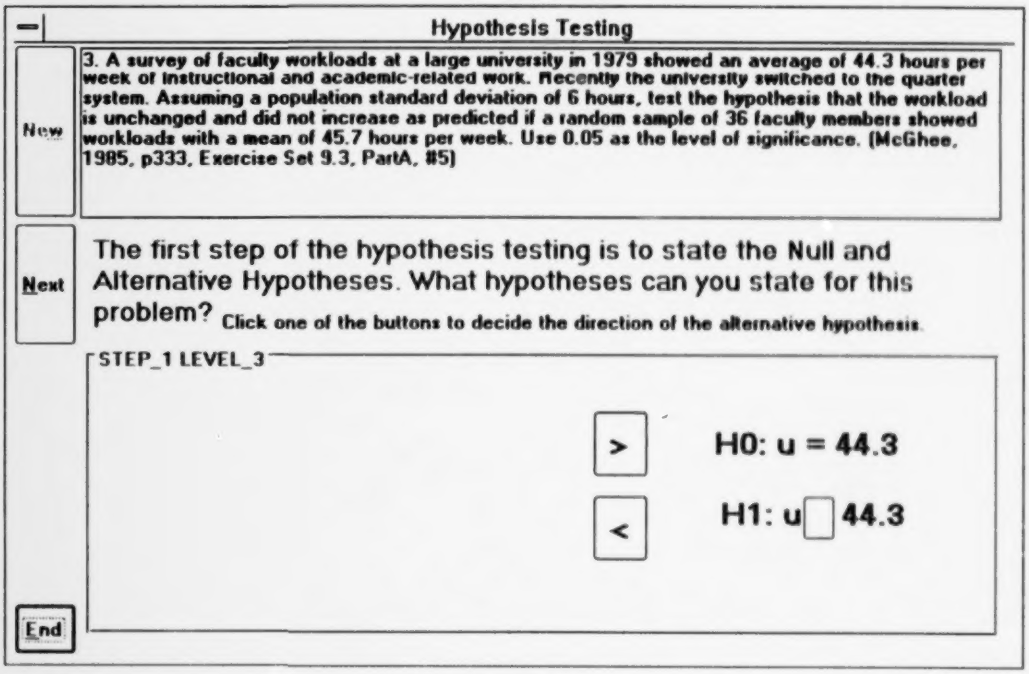
H1: u > 50

On the other hand, if the "<" is selected, the result will be:



Level 3: *Verbal and Symbolic Support*

The information in the figure area disappears. Only the verbal hint is provided, telling the learner some specific information to look for and asking him/her to provide answers after the symbolic prompts. The following figure is an example screen with this level of support.



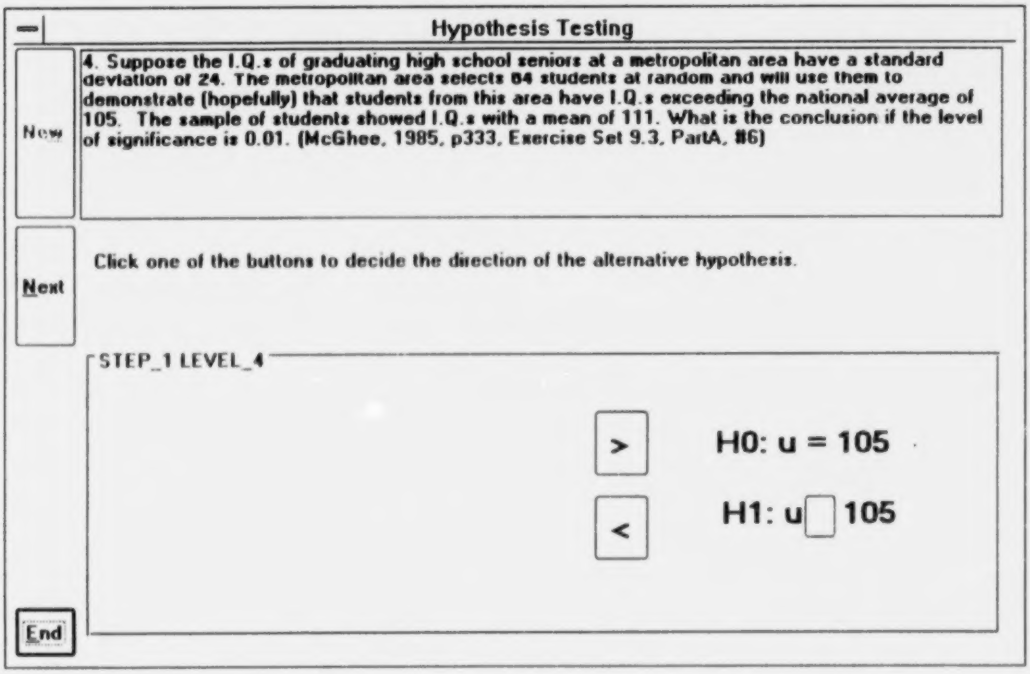
3. A survey of faculty workloads at a large university in 1979 showed an average of 44.3 hours per week of instructional and academic-related work. Recently the university switched to the quarter system. Assuming a population standard deviation of 6 hours, test the hypothesis that the workload is unchanged and did not increase as predicted if a random sample of 36 faculty members showed workloads with a mean of 45.7 hours per week. Use 0.05 as the level of significance. (McGhee, 1985, p333, Exercise Set 9.3, PartA, #5)

The first step of the hypothesis testing is to state the Null and Alternative Hypotheses. What hypotheses can you state for this problem? Click one of the buttons to decide the direction of the alternative hypothesis.

The visual hints of the current step have been taken away.

Level 4: *Symbolic Support*

The instruction takes away the next most concrete support from the screen. Therefore, only the symbolic prompts will be provided, requiring the learner to give answers. The following screen shows the problem step 1 with least level of the support.



Hypothesis Testing

4. Suppose the I.Q.s of graduating high school seniors at a metropolitan area have a standard deviation of 24. The metropolitan area selects 64 students at random and will use them to demonstrate (hopefully) that students from this area have I.Q.s exceeding the national average of 105. The sample of students showed I.Q.s with a mean of 111. What is the conclusion if the level of significance is 0.01. (McGhee, 1985, p333, Exercise Set 9.3, PartA, #6)

Click one of the buttons to decide the direction of the alternative hypothesis.

STEP_1 LEVEL_4

H0: u = 105

H1: u☐105

Not only has the visual support been taken away, the verbal hints are no longer shown on the screen either.

The combination of the 4 component steps of the task and the 4 levels of the support makes 16 possible learning situations:

	LEVEL 1: Full Support	LEVEL 2: Visual, Verbal, & Symbolic Support	LEVEL 3: Verbal & Symbolic Support	LEVEL 4: Symbolic Support
STEP 1: State the Hypotheses				
STEP 2: Find the Critical Value				
STEP 3: Compute the Test Statistic				
STEP 4: Make the Decision				

Based on the 16 learning situations, 16 templates of the information screens were created in the program.

3. Repetitive authentic practice

The problems were adapted from examples in statistics text books, covering the real problems in many disciplines: agriculture, biology, engineering, pharmacy, business, and the social sciences.

4. Ongoing assessment

At the end of each step, the learner's answer is judged for correctness. This judgment decides the next learning situation the learner will encounter.

Recall the navigation rules of the 3-D learning journey described in the previous section:

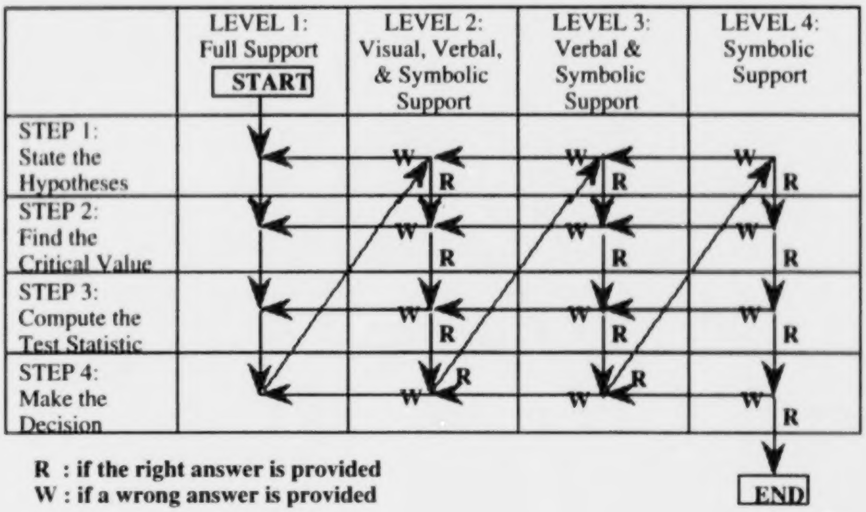
1. Each practice involves a full performance of steps 1 to 4;

2. The first practice starts with the highest level of support-- Level 1. After that, each practice starts with the level of support which is one level lower than the latest one used in the previous practice;

3. At the current level of support, the learner has the chance to work on the following sub-tasks unless he/she encounters any difficulty.

4. In each step of the practice, if the learner encounters any difficulty, the support level is increased by one until reaching the highest level-- Level 1.

If we project all the possible 3 dimensional learning journeys on to the 2 dimensional table of the 16 learning situations, the possible learning paths are:


LEVEL 1: Full Support
START
LEVEL 2: Visual, Verbal, & Symbolic Support
LEVEL 3: Verbal & Symbolic Support
LEVEL 4: Symbolic Support
STEP 1: State the Hypotheses
STEP 2: Find the Critical Value
STEP 3: Compute the Test Statistic
STEP 4: Make the Decision
W
R
END
R : if the right answer is provided
W : if a wrong answer is provided

We believe this model provides a systematic way to integrate the method of scaffolding and the integrated-media based instruction. Because this model not only bridges the learner's skill levels but also effectively withdraws support, the learner can finally become an active and independent learner. Therefore, this specific scaffolded computer-based instruction, "Hypothesis Testing-- the Z test", was expected to be an effective and powerful instructional program, inheriting the advantages and minimizing the limitations of scaffolding. In this study, this scaffolded instruction was evaluated in terms of comprehension, knowledge maintenance, and knowledge transfer by comparing it to the full-support instruction (in which the full support is available all the time), and the least-support instruction (in which only the symbolic support is provided, prompting for the answers).

EVALUATION OF "HYPOTHESIS TESTING-- THE Z-TEST"

"Hypothesis Testing-- the Z-Test" has been evaluated to address three major questions and corresponding hypotheses:

- Would the availability of full support in the computer-assisted learning hamper learner's independence? Our hypothesis was that the students in the full support condition would not perform better than the students in the least support condition (the control condition) in the maintenance and transfer posttests, where the support was no longer available.

- Would scaffolded instruction enhance knowledge maintenance in a computer-assisted learning environment? Our hypothesis was that students in the scaffolded condition would perform better in the maintenance posttest than students in the other two conditions.

- Would scaffolded instruction promote knowledge transfer in a computer-assisted learning environment? Our hypothesis was that students in the scaffolded condition would perform better in the transfer posttest than students in the other two conditions.

A secondary interest was about the subject matter itself.

- Could the subject of "Hypothesis Testing" be taught at low mathematical level? Our hypothesis was that students with low mathematical skills would also benefit from this scaffolded instruction.

The Experiment

Research Design

Based on the research questions and hypothesis described above, a baseline-posttest control group design was implemented using the computer program, "Hypothesis Testing-- the Z-test". All the hypotheses were analyzed under a regression model.

Regressor Variables

There were two types of regressor variables considered in this study.

1. Baseline Variables

The learner's mathematical and statistical background was measured from six different aspects. They were: courses taken in Mathematics (MATH_C), courses taken in Statistics (STAT_C), self-rating mathematical skills (MATH_S), self-rating statistical skills (STAT_S), mathematics preference (MATH_P), and statistics preference (STAT_P).

Besides, the pretest score was also collected as a baseline measure of their prior knowledge about the topic to be taught.

2. Treatment Variable-- the support condition

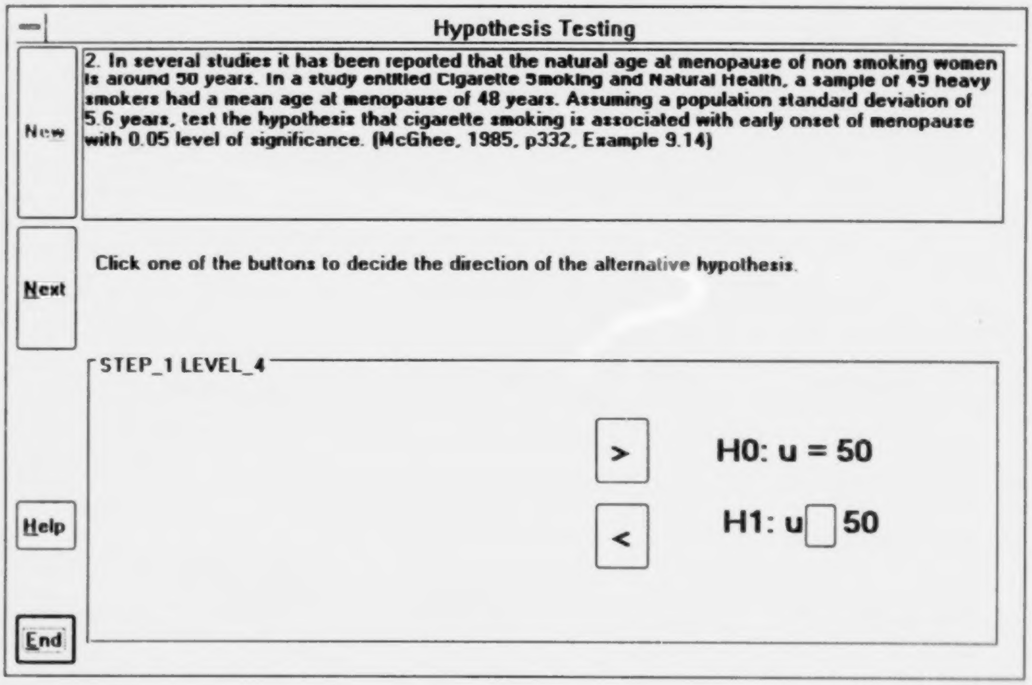
To test the effectiveness of the scaffolded instruction, the full support and the least support versions of "Hypothesis Testing-- the Z-Test" were also created. The three different instructional conditions are described below.

Scaffolded Condition (adjusts level of support among 1, 2, 3, and 4 in an orderly fashion depending on the learner's current ability)

Based on the four levels of support, the program started from the level of full support. The amount of support was reduced by one level in the next problem as the user demonstrated the ability to solve the present problem at the current level of support. Once the user encountered difficulty at any step of the problem-solving process, the amount of the support would be increased by one level for the current problem step immediately. The teaching process proceeded until the user could solve two consecutive problems with the lowest level of support.

Full Support Condition (swing between levels of support 1 and 4)

This condition represents the support condition which has been used in many computer-assisted learning environments. The program first demonstrated the complete problem solving procedure in a full-support example. Then it gave another problem with the least amount of support (i.e. symbolic support) as a test. Full support was a screen option which can provide immediate help if the user encountered any difficulty in the problem-solving process (see the following figure). If the user did not ask for full support but made any mistake in any step of the problem solving procedure, the full support would be provided starting from the current problem step. The current problem would then be solved as an example and the next problem would be presented with the least level of support as a test again. That is, the program support swung between the levels of full support and least support. The teaching process proceeded until the user could solve two consecutive problems with the least amount of support.

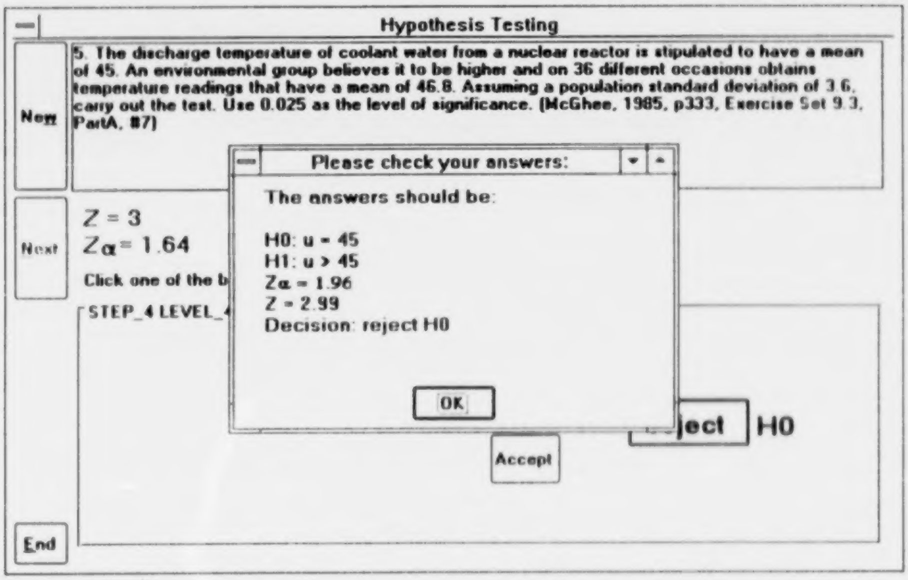


2. In several studies it has been reported that the natural age at menopause of non smoking women is around 50 years. In a study entitled Cigarette Smoking and Natural Health, a sample of 45 heavy smokers had a mean age at menopause of 48 years. Assuming a population standard deviation of 5.6 years, test the hypothesis that cigarette smoking is associated with early onset of menopause with 0.05 level of significance. (McGhee, 1985, p332, Example 9.14)

Click one of the buttons to decide the direction of the alternative hypothesis.

Least Support Condition (use level of support 1 once, then level of support 4 for the rest)

This condition of program support represents the traditional teaching method which has been used in many statistic textbooks. It served as a control condition. As in the other two treatment groups, the program first explained the four steps of hypothesis testing procedure in a sample Z-test problem thoroughly (i.e. with full support). However, in the following problems, only the least amount of support (i.e. symbolic support) was provided. The user's response in each step was judged for correctness at the end of each problem. If any mistake occurred in any step of the solving procedure, the correct answers would be provided without explanation (see the following figure). The process proceeded until the user solved two consecutive problems.



5. The discharge temperature of coolant water from a nuclear reactor is stipulated to have a mean of 45. An environmental group believes it to be higher and on 36 different occasions obtains temperature readings that have a mean of 46.8. Assuming a population standard deviation of 3.6, carry out the test. Use 0.025 as the level of significance. (McGhee, 1985, p333, Exercise Set 9.3, PartA, #7)

$Z = 3$

$Z\alpha = 1.64$

Click one of the b

STEP_4 LEVEL_4

Please check your answers:

The answers should be:

H0: u = 45

H1: u > 45

Zα = 1.96

Z = 2.99

Decision: reject H0

All conditions of the instructional program accessed the problems from a data file which contained 20 problems involving Z-test about one-tailed single sample mean.

Response Variables

Two response variables were involved in this study. They were students' scores on the maintenance posttest and transfer posttest.

Subjects

Subjects were 72 students enrolled in an introductory course of educational psychology at Purdue university in the Fall semester of 1995. The majority of the students were juniors and sophomores in educational majors.

Before their participation, the concepts of the normal distribution, standard deviation, and the Z-score had been covered in the first 6 weeks of the course. Therefore, the materials of instructional program were relevant and appropriate to the students.

The participation of the study was counted as two-hour research credits. Students were invited on a volunteer basis. Subjects were then randomly assigned into the three condition groups.

Instruments

All the tests were administered in paper-and-pencil format with a calculator and a copy of the Z-score table provided.

Pretest and Maintenance Posttest

Each test consisted of three problems involving a one-tailed Z-test of single sample means. Each problem consisted of four steps and each step involves at least three different subconcepts. Therefore, a total score of 48 was possible.

Transfer Posttest

It contained one one-tailed and two two-tailed Z-test problems of single sample means. Each problem consisted of four steps and each step involves at least three different subconcepts. Therefore, a total score of 48 was possible.

All the test problems were adapted from statistic textbooks and previewed by two experts in statistics.

Procedure

The experiment was conducted in the seventh to tenth weeks of the Fall semester of 1995. It consisted of two sessions with 7 to 10 days in between. For better control of the experiment, the first session was conducted by one of the researchers, one student at a time.

Session One

The participant first completed a participant survey at the beginning of the first session of the experiment. Then the participant was informed of the session agenda and the expected time spent on each activity. After that, the researcher checked the participant's mouse skill and demonstrated the skill if necessary. Before working on the computer, the participant was provided with a simple, hand-held calculator, a Z-score table, and a couple of worksheets for notetaking and calculation. The participant could keep and use these tools for the rest of the session. The participant then started to work on the pre-instruction in front of the computer for about 20 minutes. The pre-instruction covered all the prerequisite skills needed for the major instruction. Then, for 10 minutes, the participant had a chance to self-evaluate the key concepts learned in the pre-instruction by working on the paper-and-pencil prerequisite test. A key with detailed explanation was provided. After the prerequisite test, the participant was given a three-problem pretest to work on. The participant was told at the beginning that he/she was not expected to know the answers to these problems. If having spent more than three minutes on one problem but was unable to proceed, he/she could quit the pretest there. The expected time for the pretest was 10 minutes. After completing the pretest, the participant went back to the computer screen and work on the major instruction for 45 minutes. The instruction started with a short introduction of the lesson environment. After that, the program demonstrated a step by step procedure to carry out the Z-test in a problem example. Then the participant encountered a series of similar problems requiring him/her to provide the answers step by step. Along with these problems, one of the program support conditions (scaffolded, full support, or least support) was applied, depending on which condition group the participant had been assigned into. The program could not be terminated until the participant solved two consecutive problems with the least amount of support. However, the researcher would ask the participant to stop if he/she had spent more than 45 minutes on the major instruction and not finished. During the instruction, the participant could either use the computer and the Z-score table at hand or the ones on the computer screen. The participant's learning path and responses were recorded in an output file. The number of problems the participant went through either to mastery or by reaching the time limit was noted.

Session Two

This session was held about 7 to 10 days after the instruction session. The subject first was asked to complete the three-problem maintenance posttest for 20 minutes. After the test, a one-page instruction on two-tailed Z-test was provided. After 10 minutes, the instruction sheet was taken away and the three-problem near transfer posttest was administered. Again, the subjects could work on the test for 20 minutes. Upon completion of the test, the solutions to all the test problems were provided to the subject.

Data Analysis and Results

One-way ANOVA was first conducted on pretest to establish pre-study equivalence. Then, regression analysis was applied to both response variables (Maintenance Posttest and Transfer Posttest) with the eight regressor variables (Support Condition, Pretest, MATH_C, STAT_C, MATH_S, STAT_S, MATH_P, and STAT_P).

Pretest

The following table shows the results of the test for the group difference on pretest.

Group	Sample Size	Mean	Std Dev	F Value	Pr > F
Full Support	24	4.25	5.28	0.59	0.5554
Scaffolded	26	4.26	3.68		
Least Support	22	5.54	4.81		

All the three groups got low average scores on pretest. No significant difference was found among groups.

Maintenance Posttest

The sample size, mean, standard deviation, and the least square mean on maintenance posttest for each treatment group (support condition) are listed in the following table.

Support Condition	Sample Size	Mean	Standard Deviation	Least Square Mean
Full Support	24	22.20	13.23	21.43
Scaffolded	26	26.92	11.98	28.19
Least Support	22	19.70	12.29	19.07

The treatment effect on maintenance posttest was examined in the regression analysis along with other regressor variables. The following table presents a summary of the significance data for regression analysis on the maintenance posttest.

Response Variable: Maintenance Posttest

Source	F Value	Pr > F
Model (R-Square = 0.388188)	4.37	0.0002
Support Condition	2.89	0.0227
Pretest	6.53	0.0130

The data from this analysis showed significant effects for the treatment variable-- the support condition and the pretest. The effects of the rest of the regressor variables were not significant at 0.05 level of significance. Pairwise t-tests were conducted on the support condition as a post hoc analysis. The following table presents the results.

Support Condition	Full Support	Scaffolded	Least Support
Full Support	-	t = -2.05 p = 0.0442	t = 0.73 p = 0.4648
Scaffolded	t = 2.05 p = 0.0442	-	t = 2.75 p = 0.0078
Least Support	t = -0.73 p = 0.4648	t = -2.75 p = 0.0078	-

The least square mean score of the scaffolded group was significant higher than the other two groups at 0.05 level of significance. No significant difference were found between the full support group and the least support group.

Transfer Posttest

The sample size, mean, standard deviation, and the least square mean on transfer posttest for each treatment group (support condition) are listed in the following table.

Support Condition	Sample Size	Mean	Standard Deviation	Least Square Mean
Full Support	24	25.39	15.54	26.50
Scaffolded	26	30.98	10.15	29.58
Least Support	22	27.50	13.22	27.94

The treatment effect on transfer posttest was examined in the regression analysis along with other regressor variables. The following table shows the significant results of regression analysis on the transfer posttest.

Response Variable: Transfer Posttest

Source	F Value	Pr > F
Model (R-Square = 0.376209)	4.15	0.0003
Pretest	6.36	0.0143
STAT_C	4.76	0.0329
MATH_S	6.97	0.0105

The preceding data suggested that the transfer posttest score was significantly influenced by the pretest score, the statistics courses taken before, and the learner's self-rating mathematical skill. The effects of the rest of the regressor variables were not significant at 0.05 level of significance, including the treatment effect (the support condition).

Discussion

Maintenance Posttest

The Support Condition

The results support our first hypothesis. The students in the full support condition did not perform significantly better than the control group (i.e. the least support group). The availability of full support in the program, "Hypothesis Test-- the Z-Test", did hamper learner's independence. On the other hand, the results indicate that the scaffolded instruction was quite successful in this study. The scaffolded group got significantly higher average score than the other two groups. Our second hypothesis was also verified.

This finding is consistent to the suggestion proposed by the Cognition and Technology Group at Vanderbilt University (1993). To avoid the learner over relying on the support provided in the integrated media, its designs should function to provide scaffolding rather than always provide full support.

Pretest Score

It is not surprising that the students' performance on maintenance posttest was influenced by their prior knowledge on the topic. Actually, the results also shows that most of the students did not have any prior knowledge on the target learning task (applying the Z-test) except the very basic statistic concepts taught in the introductory course (such as normal distribution and standard deviation). However, the understanding of these very basic concepts (which was reflected on the pretest score) might improve the learner's statistical reasoning on the learning task (which was reflected on the posttest scores). Basically, the background of this subject group was very homogeneous. No significant differences were found among the three treatment groups.

Other Baseline Measures on Learners' Mathematical and Statistical Background

The results show no significant effect for any of these baseline variables. The finding on learners' mathematical background supports our last hypothesis. Since the maintenance posttest score was not affected by the learner's mathematical background, students with low mathematical skills would also benefit from this scaffolded instruction. Only 4 to 6 students in each group had ever taken Statistics course before. The finding of no significant effects of learners' statistical background also shows that the content can be taught to statistical beginners.

Transfer Posttest

The Support Condition

The findings failed to support our third hypothesis. The transfer posttest score was not significantly influenced by the support condition. There are four possible explanations:

1. The two-tailed tests on the transfer instrument actually involved the same four steps as the one-tailed tests. The one page example of a two-tailed case gave the learner a chance to review and recall the four steps.

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2. Instead of showing one step at a time on the screen, the one page example presented the four steps all together on the same page. It have given the learner a whole view of the statistical reasoning.

3. The two-tailed tests did not involve deciding the direction of the alternative hypothesis. However, that's the most crucial concept in the one-tailed tests. Many students expressed that the two-tailed cases were easier than the one-tailed cases.

4. The treatment condition may promote immediate learning but not transfer.

Therefore, most of the learners got a higher score on the transfer posttest. Although the group difference on transfer posttest did not reach the significant level, the scaffolded group still got a higher average score and a smaller standard deviation than the other two groups. One interesting finding was that the least support group got a higher mean score and a smaller standard deviation than the full support group. This might be explained by the least support group having a higher pretest score or the least support group actually needed to spent more mental effort to carry out the test on their own.

The Pretest

The effect of the pretest also was apparent on the transfer posttest. This result was expected.

Other Baseline Measures on Learners' Mathematical and Statistical Background

Only the courses taken in Statistics (weighted by the course level) and the self-rating mathematical skills (on a scale of 10) showed significant effects for the transfer posttest score. This result suggests that students having more statistical background, feeling more confident about their mathematical skills transferred the old skill to the new learning situation better.

CONCLUSIONS

In this paper, the 3-D contingent scaffolding model has been discussed, implemented, and evaluated on a computer-based instruction, "Hypothesis Testing-- the Z-Test" in order to establish baseline data for integrated-media-based instruction and hypermedia based learning environment. The results indicate that this model can be successful in promoting learning. This model provides a systematic way to link the concept of scaffolding to the integrated media design features using both support building and fading techniques. It could be adapted to other integrated media learning environments and for other content and other audiences.

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Title:

Formative Research on the Simplifying Conditions Method (SCM) for Task Analysis and Sequencing

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The Simplifying Conditions Method (SCM) is a relatively new set of guidelines for task analysis and sequencing of instructional content under the Elaboration Theory (ET) (Reigeluth & Rogers, 1980; Reigeluth & Stein, 1983). During the last 20 years, even though ET has been one of the most well-received and extensively referred to method used by practitioners and researchers (Wilson & Cole, 1992), SCM has received relatively less attention compared to its potential strength as a tool for task analysis and sequencing.

Initially, SCM was developed for the procedural task (focusing on "how") by Reigeluth and Rogers (1980); it has been elaborated and proven that SCM also works well for the transfer task (focusing on "why") (Reigeluth & Kim, 1991). Since 1991, we have invested a lot of effort into improving and extending the scope of SCM while incorporating knowledge from the current advances of cognitive psychology and constructivism (Reigeluth, 1992; Wilson & Cole, 1992) and from the several empirical field applications and testings (Kim, 1994; Reigeluth & Kim, 1991, 1992, 1993). Since our findings provided meaningful information, giving us a relatively high level of confidence in SCM, we conducted formative research on SCM to finalize and synthesize our efforts.

This article introduces the fundamentals of SCM and shares the findings from our formative research on SCM.

Fundamentals of the Simplifying Conditions Method (SCM)

SCM was developed to add more detail to the Elaboration Theory, which resulted from Reigeluth's intensive work to integrate the knowledge base of instructional and learning theories into a set of prescriptions at the macro-level (Reigeluth & Stein, 1983). Consequently, the most important ideas of ET are based upon Gagné's (1977) hierarchical task analysis and sequence, Bruner's (1960) spiral curriculum, Ausubel's (1963) progressive differentiation, and Merrill's (1978) and Scandura's (1973, 1983) shortest-path sequence.

One of the most important theoretical elements of ET is a special kind of simple-to-complex sequence. The whole notion of elaborative sequence is based on a single type of content which is the most important type for achieving the general goals of the course. ET categorizes the content of the course with three types—concepts, procedures, or principles. When an elaborative sequence has been done to each of them, it is called a conceptual organization, a procedural organization, and a theoretical organization (Reigeluth & Stein, 1983).

SCM provides practical guidelines for making the elaborative sequence for procedural and theoretical (transfer) organization. The SCM process begins with finding conditions which make a task complex, non-representative, and difficult for learners. Then, it constructs an epitome which is simplified—an easy but still representative version of the task—by removing or dissolving the conditions of the complex task. The learners will start learning from the epitome so that they can work with the epitome without experiencing too much difficulty, but still be able to taste the representative flavor of the whole task. Subsequently, the conditions are gradually removed or dissolved according to a preassigned priority, and the more complex and difficult version of the task can be introduced. In this manner, the whole version of the task will be presented smoothly and meaningfully (Kim & Reigeluth, 1995a, 1995b).

SCM is composed of two major parts—an underlying theory, which functions as a framework, and a process, which is used as a guideline to embody the underlying theory.

SCM principles

The underlying principles of SCM fall into two categories: those that govern epitomizing and those that govern elaborating the version of the task. If epitomizing can be compared to sketching, then elaborating can be compared to adding detail to the sketch. So, with a good epitome and good elaborating, it is possible to make a sound sequence (Kim, 1994). Figure 1 illustrates these relationships.

Epitomizing principles. The principles of epitomizing are based upon the notion of holistic learning. Therefore, an epitome should begin with

- a whole task rather than a part of a task,
- a simple version of the task,
- a real-world version of the task if possible, and
- a representative version of the task.

Elaborating principles. After the epitome is identified, elaborating entails designing each subsequent module to teach another version of the whole task. Each elaboration should be slightly

- more complex,

- more divergent,
- more authentic, and
- less typical.

The SCM process

While the principles of SCM provide conceptual understanding about SCM for designers, the SCM process provides specific guidelines so the designers can apply their understanding.

We have worked with several versions of the SCM process since 1991. Since the version outlined in List 1 was the most recent version at the time, it was used for the study.

RESEARCH PROBLEMS

The purpose of this study was to improve the principles and process of the Simplifying Conditions Method for the procedural tasks by using formative research methodology with field testing. More specifically, this study investigated the following questions:

- What are the weaknesses of the principles of SCM?
- How can they be improved?
- What are the weaknesses of the SCM design process?
- How can they be improved?

FORMATIVE RESEARCH FOR INSTRUCTIONAL THEORY

The major research methodology for this study is the formative research methodology (Reigeluth, 1989) which is designed to improve the instructional theory and model. Using the formative research method to improve instructional design theory was a relatively new idea until Reigeluth (1989) suggested it as a means of improving prescriptive instructional theory. Since then, several studies have used this methodology for that purpose (Clonts, 1993; English, 1992; Farmer, 1989; Kim, 1994; Lim, 1994; Roma, 1990; and Simmons, 1991). These studies suggest that formative research methodology is an effective tool for improving instructional theories.

Reigeluth's (1989) formative research methodology is based on the principle that when instruction is developed under the strict guidance of a theory, without using any other guidelines or input—not even the designer's own intuition—the instruction (product) is an "instance" of that theory, and the results of the evaluation of the instruction will reflect the theory's weaknesses and strengths and will point to ways of improving the theory.

The process of formative research for instructional theories has similarities to and differences with formative evaluation for instructional products. Generally, formative evaluation begins when the designers and/or developers of the product have a basic but minimal level of confidence in the product and wish to determine early on any weaknesses of the product. This formative evaluation process can be repeated until the designer is satisfied with the revised product.

The process and purpose of formative research on an instructional theory or model are similar. An instructional theory or model requires a significant amount of trial and revision. Formative research should begin only when the creators of the instructional theory or model have a basic level of confidence and are ready to examine their product (the theory or model) for flaws. Formative research is complete only when the creators are satisfied with the modified version of the theory, which is based on the formative research results.

Also, there is a significant difference between formative evaluation of a product and formative research on an instructional theory. In the formative evaluation of an instructional product, a designer can collect data on the product from the learners directly (see Figure 2). The data-gathering process for formative research on an instructional theory is not as simple, however, since learners' data are gathered through the "instance" of the theory (see Figure 3). Consequently, the validity of the data from the formative research for the theory is much more important and critical than those of the formative evaluation for product. For the formative research, the "instance" must truly represent the theory. This distinction introduces following salient issues which should not be overlooked when considering the validity of a formative research study (Kim, 1994).

First, since the instructional designer develops the "instance" according to his or her understanding of the theory or model, the designer's ability to apply the theory is one of the critical factors in research validity. If the designer is an expert on the theory or model and has considerable experience developing "instances" of the theory, the validity of the study will generally be acceptable. However, if the designer lacks significant knowledge and/or experience regarding the theory, the validity of the study may be negated, since the "instance" may not accurately reflect the theory or model.

Second, even though an "instance" can be determined by a theory expert, it is recommended that another expert on the theory confirm this "instance" to lend further credence to its validity. Consequently, the first and second issues can be summarized into one question—"Is the product a true instance of the theory?" This raises the issue of construct validity. Third, when the product is "delivered" to the learners, the learning environment should be as natural as possible in order to increase the external validity (Reigeluth, 1989). It is also necessary to determine whether the characteristics of the task and the learners are realistic and representative the instructional settings to which one wishes to generalize.

Fourth, data gathering can be a critical issue in formative research on an instructional design theory or model. The following questions should be considered in the planning process: "What kind of data will be really useful for improving the theory?" and/or "How are useful data gathered?" (Reigeluth, 1983). The characteristics of the instructional design theory or model—sequencing, selection, instructional strategies, and/or task analysis—should be considered when answering these questions.

In previous formative research on instructional theories or models (Clonts, 1993; English, 1992; Farmer, 1989; Kim, 1994; Lim, 1994; Roma, 1990; and Simmons, 1991), data gathering relied heavily, but not exclusively, on the use of qualitative data.

DESIGN

This study was conducted in two distinct phases: design and instruction. In the first phase, we used the SCM process to design a course. This was done to determine the weaknesses of the SCM process. In the second phase, the course was taught using the SCM sequence. This was done to determine the weaknesses of SCM principles.

FIRST PHASE

Task

The task for this study was to use Authorware Professional to create a CAI program. It was selected based upon the following criteria:

1. The task should be procedural or theoretical, so that the procedural or theoretical SCM analysis and sequencing methodology can be used.
2. There should be a strong interrelationship among the topics in the task. (If the learning task were composed of unrelated topics, it would not be useful for this study.)
3. The context, task, and audience should resemble a normal instructional setting as much as possible in order to increase the external validity (Reigeluth, 1989). It is also necessary to determine whether the characteristics of the task and the learners are realistic and representative the instructional settings to which one wishes to generalize.
4. The task should require more than 10 hours to learn, including the time required for in-class activity as well as the time required to complete practice exercises and homework. If the task is short and requires less than 10 hours to master, learners can compensate for any weakness of the sequence and the sequence does not make any big difference on the effectiveness and efficiency of learning.
5. There should be a meaningful interval of time between one lesson and the next so the students can practice and review what they have learned.

Participants

An SCM design committee of six members was established to design the SCM sequence. Their specific roles were as follows:

1. The designer designed the sequence with the subject matter experts (SMEs) while using SCM.
2. The two SMEs designed the sequence with the designer and checked the content validity of the sequence of instruction.
3. The peer-debriefer gathered data while observing the design activity of the designer and the SMEs.
4. The task expert checked the content validity of the designed sequence of instruction to ensure it taught the task.
5. The SCM expert checked the construct validity of the designed sequence of instruction as an SCM sequence.

Data Gathering and Data Analysis

Data were collected by employing three different processes: (1) self-monitoring (Krieger, 1991) and self-reflection (Schön, 1987) by the designer; (2) the observations of the peer-debriefer (Lincoln & Guba, 1985); and (3) debriefing with the designer, peer-debriefer, and content SMEs who participated in the design process.

The gathered data were analyzed mainly by triangulation (Denzin, 1978; Miles & Huberman, 1984) among the gathered data from the three processes: designer's self-monitoring and self-reflection note, peer debriefer's observation note, and the comments from the debriefing meetings. More specifically, the following questions were answered: What results are similar among the data? What is the difference among data? What causes the differences or similarities?

Procedure

To design the sequence of the task within the parameters of SCM, the designer, one SME, and the peer-debriefer met in a quiet place at the SME's company. While designing the sequence with the SME according to the SCM process, the designer tried to note in detail every problem or question that arose. The peer debriefer also tried to maintain a complete working log for each step of SCM. It took about 13 hours total over three days to complete the design sequence. After each day's work, the designer cross-checked the gathered data with the peer-debriefer and/or the SME.

After completing the sequence design, the content validity and the construct validity of the sequence were checked with the task (Authorware Professional) expert and SCM expert.

Results

The findings from the first phase, according to the identified weaknesses, could generally be placed into four categories: (1) need more prescriptions, (2) need to consider the holistic approach more, (3) need to teach SME, and (4) need to consider job aid/performance of designer/SME (see Table 1). Each weakness was also analyzed to determine whether it could be strengthened by modifying the step(s) or criteria or by adding new step(s) or criteria. In Table 1, for instance, "A:11" and "M:13" from the first column indicate that 11 more steps need to be added and 13 existing steps need to be modified with more detailed prescriptions.

Discussion

In general, the SCM process works fairly well and successfully reflects the principles of SCM. However, the results of this study clearly show why the

SCM process requires further improvement and what needs to be improved. First, issues related to improving the SCM process need to be considered—is it really possible to perform task analysis and sequencing with the SCM process? Second, issues related to specific aspects of the performance of SCM designers and SMEs also need to be considered—if a designer performs SCM for the first time, how well can he or she do task analysis and sequencing with SCM?

Since the second group of issues is more related to training or training materials development in ISD processes and more dependent on the performance of designer, the original focus of this study was on the first category—checking the soundness of the SCM process as a design process. For instance, some of the steps from the "need more prescriptions" category and all of the steps from the "need to consider holistic approach" category focus on the soundness of the process. If those steps were not added or modified, the vitality of the SCM process would be questioned as an instructional design theory. However, most of the steps of the other three categories—the rest of the steps from "need more prescriptions" and all of the steps from "need to teach SME" and "need to consider job aid/performance of designer/SCM" focus mainly on the performance of designers and SMEs. Therefore, those steps do not threaten the vitality of the SCM process. Without them, however, the efficiency and effectiveness of the SCM process would be endangered. Consequently, in order to improve any instructional design theory, both aspects must be considered and addressed.

Issues Concerning the Soundness of the SCM Process

The soundness of the SCM process depends on the consideration of two issues: (1) the holistic relationship between the principles and process and (2) formative evaluation of each level of sequencing.

Holistic relationship between the principles and process. The current SCM process may be misunderstood if treated as a step-by-step recipe-style procedure. Such problems can occur when the SME asks too many questions or demands too much deviation from the SCM process. Excessive deviation is risky because the SCM process requires a very dynamic/recursive type of iteration, a fine-tuning process, on the part of the design committee.

In fact many people have warned about the potential problem of the overproceduralization of complex ISD processes (Davies, 1983; Earle, 1985; McCombs, 1986; Shettle, 1983). The Elaboration Theory has also been criticized for the possibility of overproceduralization (Reigeluth, 1992; Wilson & Cole, 1992).

In order to forestall such problems, the SCM process must be expressed in a way that leaves its step-by-step prescriptions more holistically integrated with its principles. This can be done in two ways. First, one would display the relationship between the principles and the process more clearly within SCM process by, for instance, integrating a display of the related principles into the flowchart representation of the process. Second, one would emphasize more flexibility in the process within the scope of the principles, so that the design activity can be more systemic rather than systematic.

Formative evaluation of each level of sequencing. Formative evaluation is recommended for each level of sequencing. The scope of formative evaluation can be very broad, encompassing one-on-one evaluation, small group evaluation, and field testing. Consequently, new prescriptions for the allowable scope, participants, and purpose of the formative evaluation should be developed, taking into consideration the rapid prototyping approach such as the following:

1. After making each unit of the sequence, there should be at least one one-on-one evaluation of the unit.
2. For the one-on-one evaluation activity, the learner should be realistic and representative of the targeted learners.
3. Evaluation criteria should include effectiveness, efficiency, and appeal of the instructional unit.

Issues concerning the Performance of Designers and SMEs

Although this study made separate efforts to find weaknesses in the principles and process of SCM, these two elements are holistically interrelated. Within this interrelationship, the success of SCM principles is relatively dependent on how well the designers understand SCM, while the success of the SCM process is relatively dependent on the performance of the designers and SMEs, which is based on this understanding and training. Consequently, the success of the principles (understanding) and the success of the process (performance) are, taken together, necessary and sufficient conditions for the success of SCM.

Viewed from this perspective, it appears that the current version of SCM might be improved by considering the performance and understanding of designers and SMEs on the following points:

- The SCM process needs to be described in plainer and more explicit terms.
- The available criteria are insufficient to evaluate the success of some steps.
- Easy concrete examples of the SCM approach would enhance the understanding and performance of the SMEs and the designers.

SECOND PHASE

In the second phase, using the product of the first phase's design activity, the designer taught the workshop for instructional designers at the Computer Education Research Center (CERC) of the Korean Education Development Institute (KEDI) in Seoul, Korea. The designer also gathered data from interactive interviews with participants of the workshop and observed the class. Likert-style data on their attitudes were gathered from the learners. All gathered data were checked and analyzed by triangulation with other learners.

Method

Participants

There were 10 participants for the second phase. Since the second phase was an unofficial internal workshop of a research/development institute which specializes in research and production of computer-based instruction, all of the participants were instructional designers employed by the institute. Each person had designed about five CAI programs every year and had worked at the institute for at least two years as an instructional designer. Some participants were fluent in using some authoring systems/languages, but none had had any prior experience with Authorware Professional.

Data Gathering

While conducting the workshop, the instructor gathered data through personal interviews with participants, assignments, observation, and the instructor's personal reflections. After completing the workshop, the instructor held three debriefing meetings with small groups of participants.

Procedure

The second phase included three stages—initiating, implementing, and debriefing.

Initiating stage. Before starting the workshop, the instructor interviewed every participant to assess the participant's previous experiences. During the interview, the instructor explained the purpose of this study and encouraged each participant to provide honest feedback on the sequence of the workshop.

Implementing stage. The instructor taught the nine-day workshop without any other instructors or assistants. Each day of the workshop included a lecture lasting about one hour and then individual practice for at least one hour. Two assignments were given during the nine days' training, and each took about one and a half hours to complete. During the workshop, the instructor interviewed each participant at least twice to obtain meaningful and relevant information about the sequence of the workshop. During the interim interviews, the learners were asked the following questions:

- What did you like or dislike about today's activity? Is your answer related to the sequence of instruction (or ordering and grouping of instruction)?
- What do you think would enhance your motivation in the course? Is it related to the sequence of instruction?
- What would help you understand the task better? Is your answer related to the sequence of instruction?
- If you encountered difficulties related to the sequence of instruction while learning the lesson, how could those difficulties be avoided in the future?
- Is the topic too difficult? Is this because of the sequencing?
- As a learner in this course, how do you think the sequence can be changed to make the course more attractive?

After the last day of the workshop, the learners were asked to respond to a final attitude survey to assess the appeal of the instruction and the their attitudes toward the sequence of instruction. The survey was composed of 13 Likert-style questions and five open-ended questions, which asked the learners if they liked the sequence of the daily lesson. Table 2 summarizes the survey results.

Debriefing stage. After the workshop, a debriefing meeting was attended by a debriefer for the first phase, two learners, and the instructor. In the meeting, the instructor shared the findings from his observations and personal interviews and then asked some questions which had been suggested by these personal interviews and observations.

Data Analysis.

Once data collection was complete, the information was organized so that comparing the difference and similarity among the data sets could be performed. The most important data were from the interviews with the learners and from the observation record. Like the data from the first phase, the interview results from the second phase were analyzed with an emphasis data on among the learners' and instructor's observations. Our data analysis involved data reduction, data display, and drawing conclusion (Miles & Huberman, 1984).

This analysis helped us identify the major strengths and weaknesses of the sequence so that the theory could be improved. The findings of the first and second phases were used to support and develop conclusions that might help determine the underlying principles of SCM and the weaknesses of the SCM process.

Results

Generally, the data clearly show the strength of the SCM sequence. The general results of the open-ended questions also agreed with those of the Likert-style questions, in supporting the strength of the SCM approach.

Table 2 displays a summary of the attitude survey, which is composed of three major groups: (1) general attitude toward the workshop, (2) feedback on the epitome, and (3) feedback on the sequence of the workshop.

General attitude toward the workshop: The results from questions 1 to 5 display the learners' general attitude toward the workshop. For the most part, the learners were very satisfied with the workshop. The mean of the answers to questions 1 to 4 was between 1 and 2, which stands for "strongly agree" and "agree." Also, the mean for question 5 was 4.5, indicating that all of the learners felt they had successfully understood the main characteristics of the task.

Feedback on the epitome: The feedback on question 6 shows that the first lesson (epitome) was highly helpful to the learners in understanding the course as a whole. The mean of question 6 was 1.9, indicating that the learners agreed that the first lesson was very helpful in understanding the content of the course as a whole.

Question 7 originated from a learner's suggestion in an interim interview during the workshop. That person had some understanding of the Elaboration Theory and liked the idea of "epitome." He felt that if the epitome could be reviewed during the course, it would help the learners understand the relationship between the epitome and each elaborated lesson, thus encouraging better-structured understanding while allowing them to verify their progress. The learner suggested this idea in the middle of the workshop. Even so, it is interesting that this person did not strongly disagree to question 7 when it was asked after the workshop. On his survey, he noted that "even if it is a good idea, it may not be practical, since it will take a lot of time."

Feedback on the sequence of the workshop. Results for questions 8 and 10 show consistently that the sequence of the course was not very difficult and that learning one lesson facilitated the mastery of the next. The results from questions 11, 12, and 13 clearly show that the sequence of the course was very good. The generally positive responses to Question 10 support this conclusion.

The results of the personal interviews support the findings from the attitude survey. The questions and the summary of answers are as follows:

- What did you like or dislike about the course? Is your answer related to the sequence of instruction (or ordering and grouping of instruction?): Almost all of the participants liked the first lesson and sequence. One person noted that repetition of the content of the first lesson (epitome) during the first three lessons was a little boring; however, it proved very helpful for later learning for him.

- What do you think enhanced your motivation in the course? Is your answer related to the sequence of instruction?: "Since the first lesson was practical, it was not very difficult to maintain motivation. Each time we learned a limited amount of content, and there was always the potential for elaboration. Because of this potential, it was possible to peek at the content of upcoming lessons and this enhanced my motivation."
- What would help you to understand the task better? Is the answer related to the sequence of instruction?: "It might be helpful to check where the current lesson is on the big map of the whole task."
- If you encountered difficulties related to the sequence of instruction while learning the lesson, how could those difficulties be avoided in the future?: "Using window was one of the prerequisite skills for this workshop. Since I didn't know anything about the window, I had a lot of stress with window even though the class activity did not require using window a lot. It might be beneficial to have enough time to practice the prerequisite skills until I feel confident before starting any major lesson."
- As a learner for this course, how do you think the sequence can be changed to make the course more attractive?: "In general, the sequence of this course was OK for me. However, since my learning style is more inquiry-based, I would like to have a chance to explore more, rather than following the given instruction."

Discussion

In light of this study's goal—finding weaknesses so we could improve the underlying theory of SCM—the second phase was unproductive, since no significant weakness was found. This was expected, however, since the results of the pilot studies were very similar to those of the second phase. Consequently, rather than identifying weaknesses, the second phase provided some evidence of the strength of the underlying theory of SCM. Basically, it confirmed the validity of SCM's approach of providing a big picture of the task early in the instruction, thus enriching the epitome with additional elaboration efficiently and effectively, while maintaining the learners' motivation at a high level throughout the course.

Besides indicating these strengths, the results of the second phase also support the following two recommendations regarding possible improvements to the underlying principles of SCM and another one regarding the SCM process and SCM principles.

1. This study revealed a need to improve the descriptions of the principles identifying the SCM and the interrelationships among those principles by ensuring such descriptions are concrete, clear, and self-explanatory. As things now stand, designers must take a great deal of time (inventing many explanations and analogies on their own) to introduce the principles to the SME(s). If the principles are to be understood easily, workable explanations will have to be in place beforehand. One example would be calling the first day's instruction the "epitome."

2. The current way of describing the principles provides a kind of absolute set of criteria, such as "a whole task rather than a part of a task" (the first epitomizing principle). But in practice, the definition of a whole task can be varied according to the characteristics of the learners, the delivery constraints, etc. For instance, when the designer explained about the first epitomizing principle to the SME, the SME was asked about the scope of the course and other practical limits of the course. This dialog helped to identify the epitome version of the task.

Thus, it would be better to provide designers and SMEs with formulations of the principles that take these variable conditions into account. For instance, the first epitomizing principle (a whole task rather than a part of a task) could be described as "a whole task rather than a part of a task, within the limits imposed by the characteristics of the learners, their needs, the goal of the course, and the delivery constraints." In this manner, the relationship between the first epitomizing principle and the preparation stage of the SCM process can also be clarified.

3. The constructivist approach should be considered for the micro-level design. Most of the learners liked the SCM sequence; however, about 20% of learners wanted to have different ways of studying, such as explorative or constructive studying, made available to them. These results can easily mislead one into concluding that SCM limits the learners' learning style to expository only. However, SCM does not limit its application with any one way of learning such as expository or discovery. SCM can be used for discovery or in an explorative way also because SCM determines the learning sequence at the macro level and the decision of whatever to use an expository or explorative way of learning is made at the micro level. So these comments do not reflect on the SCM but rather on the decision of the designer at the micro level. For these studies of the SCM process, we implicitly used only the expository way of teaching.

These results raise an issue—prescriptions need to be added to micro-level design which can be designed for either expositive or explorative learning.

CONCLUSION

The results of this study suggest two conclusions. First, the current SCM process is workable; however, three recommendations were found for improvement.

- The need to stress the holistic rather than the step-by-step approach
- The need to add more detailed prescriptions.
- The need for formative evaluation.

Second, we were unable to find any critical weaknesses that might lead to possible improvements in the SCM principles, since most of the learners were very satisfied with the sequence of the instruction. The results of this study reveal that even though the principles of SCM are fundamentally sound, there is still room for improvement as indicated above. Therefore, future research can focuse more on the application of SCM and can confront such challenges as finding the best ways to train and guide the novice designer.

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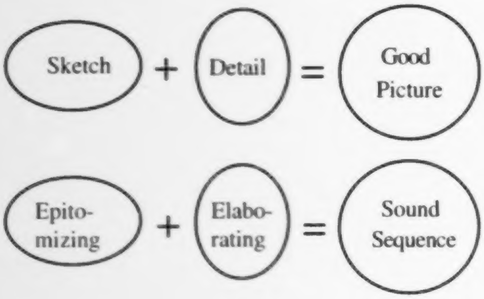
Figure 1: The underlying principles of SCM



List 1: Process for SCM procedural analysis and sequencing (1993 version).

The SCM Process for Procedural Analysis and Sequencing

(All steps are performed by a designer and a subject matter expert.)

Prepare

1) Establish rapport with subject matter expert (SME).
2) Identify the characteristics of the task in general.
3) Identify the characteristics of the learner in general.
4) Identify the delivery constraints of the task in general.
5) Introduce the SME to SCM.

Design the Epitome

1) Identify and order the simplifying conditions.
    1.1) Identify the full variety of versions of the task.
    1.2) Describe the conditions which differentiate each version.
    1.3) Rank order the conditions according to representativeness of the whole task.
2) Identify the epitome version of the task.
    2.1) Recall the simplest version that is representative.
    2.2) Describe the conditions for the epitome version.
3) Analyze the epitome version.
    3.1) Decide whether the task is procedural or theoretical. If it is procedural, continue.
    3.2) Identify all major steps for performing the epitome version under the conditions.
    3.3) Analyze each step down to the entry level of description (hierarchical analysis).
    3.4) Draw a flowchart for the epitome version.
4) Analyze supporting content for the epitome.
5) Check the size of the epitome.
    5.1) Analyze the delivery time constraints of the specific learning situation, if any.
    5.2) Compare the size of the epitome to the time constraints.
    5.3) If the epitome is longer than the time constraints, reduce its size by adding another simplifying condition.
    5.4) If the epitome is much shorter than the time constraints, increase its size by removing one of the simplifying conditions.
6) Design and develop instruction for the epitome.

Prepare for Elaboration

1) Refine the simplifying conditions.
    1.1) Identify additional simplifying conditions, if any, that may have been overlooked.
    1.2) Check for any conflict or overlap among the conditions and adjust them.
    1.3) Rank order the simplifying conditions.
2) Identify the relative amount of learning that would be required by removing each simplifying condition.
3) Identify those simplifying conditions whose removal will require learning skills similar to those for another simplifying condition.

Design the Elaborative Sequence

1) Identify the next simplest version (the next elaboration).
    1.1) According to the rank order, select the next simplifying condition to remove.
    1.2) If the removal requires additional conditions, identify them and add them to the rank order.
    1.3) Identify the version of the task that meets the new conditions.
2) Analyze the version.
    2.1) Identify all major steps for performing the simplest version under the conditions.
    2.2) Analyze each step down to the entry level of description, considering all previous instruction.
    2.3) Draw a flowchart for the lesson.
3) Analyze the supporting content for the version.
4) Check the size of the version.
    4.1) Compare the size of the lesson to the time constraints.
    4.2) If the lesson is longer than the time constraints, add in a secondary simplifying condition and return to step 4.1.
    4.3) If the lesson is much shorter than the time constraints, remove another simplifying condition according to the rank order and return to step 4.1.
5) Design and develop instruction for the lesson.
6) Repeat steps 1 through 5 for each remaining simplifying condition.

Figure 2: The Formative Evaluation Model for an instructional product.

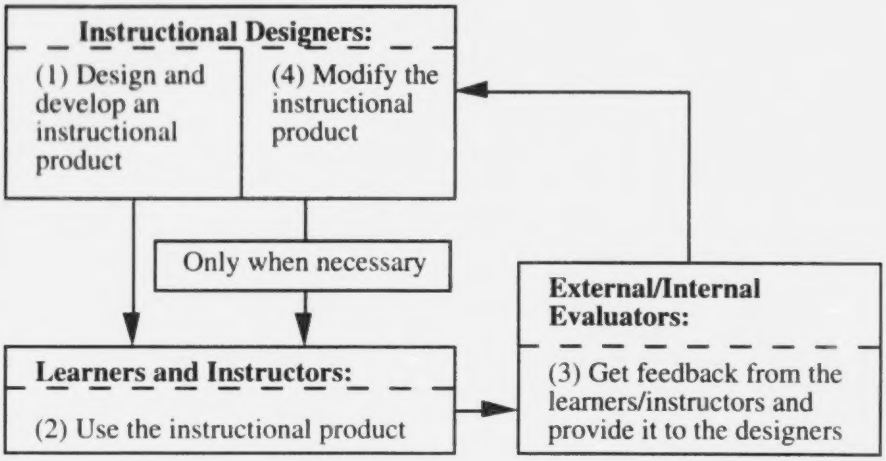

Instructional Designers:
(1) Design and develop an instructional product
(4) Modify the instructional product
Only when necessary
External/Internal Evaluators:
(3) Get feedback from the learners/instructors and provide it to the designers
Learners and Instructors:
(2) Use the instructional product

Figure 3: The Formative Research Model for an instructional theory.

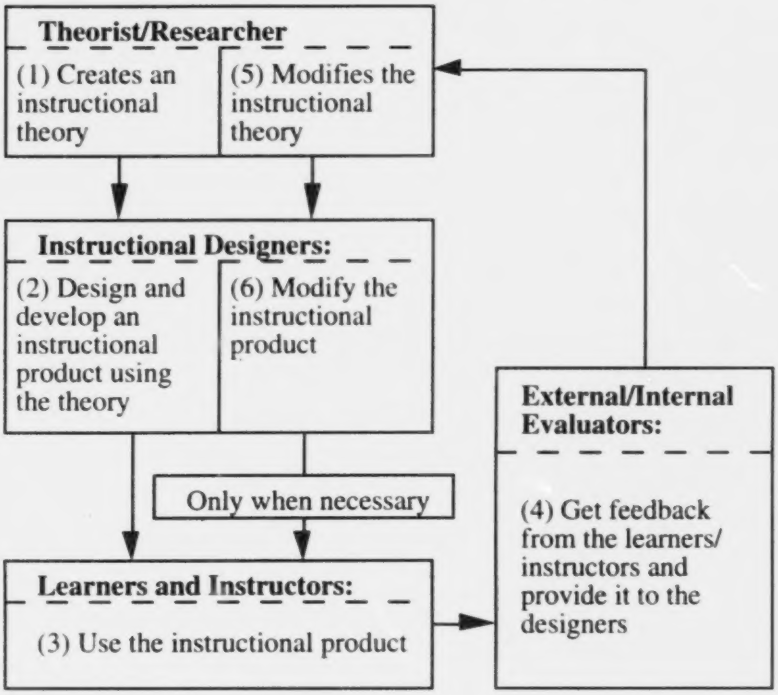

Theorist/Researcher
(1) Creates an instructional theory
(5) Modifies the instructional theory
Instructional Designers:
(2) Design and develop an instructional product using the theory
(6) Modify the instructional product
Only when necessary
Learners and Instructors:
(3) Use the instructional product
External/Internal Evaluators:
(4) Get feedback from the learners/ instructors and provide it to the designers

Table 1 Summary of the Results of the First Phase

Weakness	Need more prescriptions	Need to consider holistic approach	Need to teach SME	Need to consider job aid/performance of designer/SME
Frequency	A: 11 M: 13	A: 0 M: 5	A: 10 M: 1	A: 3 M: 1

M: Need to modify the step(s) or criteria
A: Need to add new step(s) or criteria

Table 2: Workshop Survey Results

	No.	Question	SA	A	U	D	SD
I	1	I learned a lot from this course.	9	1	0	0	0
	2	This course was very interesting.	8	2	0	0	0
	3	I really liked taking part in this course.	8	2	0	0	0
	4	I'm willing to participate again if a higher level of this course is offered someday.	4	6	0	0	0
	5	I still don't know what the main characteristics of the task presented in this course are.	0	0	0	5	5
II	6	The first lesson was very helpful in understanding the content of the course as a whole.	3	5	2	0	0
	7	It would be very good if the first lesson were reviewed during this course, in between the presentations of new material.	0	2	4	3	1
III	8	This course was too difficult for me.	0	0	0	4	6
	9	The amount of learning for each day was too much for me.	0	1	2	6	1
	10	It was not very difficult to understand the content of each new lesson, since each lesson was closely related to the previous one.	3	6	1	0	0
	11	The sequencing of topics from day to day was handled very well.	6	4	0	0	0
	12	The content was not presented in a logical sequence.	0	0	0	1	9
	13	It would have been better if the whole sequence of each lesson had been composed differently.	0	0	0	4	6

SA: Strongly Agree, **A**: Agree, **U**: Undecided, **D**: Disagree, **SD**: Strongly Disagree
I: General attitude on the workshop
II: Feedback on the epitome
III: Feedback on the sequence of the workshop

Title:

Hypermedia as a Separate Medium: Challenges for Designers and Evaluators

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Recent developments in hypermediated software suggest new challenges for instructional designers of interactive multimedia. Product enhancements provide authoring software with increased capabilities for designing and producing multimediated instruction. The enhancements permit new possibilities for the appearance and functionality of courseware, and thus pose new challenges for instructional designers.

Further, the increasing ease with which the improved authoring software can potentially be used, could lead to a situation in which people produce instructional courseware without the aid or advice of instructional designers. Products that result, whether stand-alone desktop systems or those that incorporate other resources such as material from the world wide web, have vast potential. Yet the new technological enhancements will not necessarily be applied in a way that truly improves the instruction.

Technology offers "bells and whistles" that seem to have great potential but often take the lead and interfere with instructional design. Indeed, if misapplied, the software enhancements could actually befuddle the learning process. A framework is needed to provide guidance for people who must produce instructionally sound products that utilize a mix of stagnant text, text as a dynamic visual image, still and motion visual images, and audio within a hypermediated format. Such a framework can provide the necessary guidance to make wise use of the new enhancements to the technology.

The processes of linking visual images with visual text, and making connections between realia and the meaning of the images in a hypermediated format, lead to questions about effective instructional design of courseware that incorporates those processes. Moreover, those processes cause software evaluators to rethink the standard for effective and appropriate presentations.

This paper addresses some of the challenges and dilemmas faced by two instructional designers as they incorporated visual imagery and audio components into the design of two distinct interactive multimedia products. Each instructional product was designed as a professional development seminar or series of instructional seminars for two distinctly different groups of adult learners. One product was designed for preservice teachers who spend a significant amount of time on campus and in classes, while the other was designed for practicing social workers who are employed in isolated, rural areas where access to professional development is extremely limited.

The multimedia products present content-specific information pertinent to learners through the use of visual text, still images, still and animated graphics, sound, and full-motion video vignettes contained on a laser videodisc or CD-ROM. The two programs provide learners with new information, observational examples, and interactive practice about content specific to their fields, either teaching or social work. There are many similarities shared between the instructional needs of the two products and so many design aspects are common to both, however the graphical-user interfaces between the two programs are very different.

The teacher's product contained content about the National Council of Teachers of Mathematics' Standards (NCTM, 1991). Students normally would cover this material in class as part of their regular coursework and through other techniques of instruction. The social worker's product differs in purpose. It offers ten different topics of study that are not addressed within the course of regular university preparation for social workers. The topics were determined by conducting a needs assessment with practicing social workers.

The social worker's program is quite extensive and is being developed as a series of ten separate modules with similar functionality to accommodate people who have very limited computer skills. It uses standard design elements such as text-based menus, buttons, pop-up text boxes, concept maps, and the choice of receiving audio-based, text-based, or a combination of audio and text within the instructional interface.

The teacher's program replaces text menuing with a graphical user interface (GUI) that presents familiar objects within a traditional school setting. The main menu is a graphic of a school hallway lined with doors and an exit sign. Each door leads to a room that contains desks, books, and chalkboards to access information. This program also contains an electronic notebook in which the learners can write their questions and reactions to their observations. Both programs are hypermediated, employ video vignettes, and contain a presentation component, an application component, and an assessment component.

Both product design teams were able to follow some common theoretical elements of interactive system design, yet both broke new ground in their own way as they strove to create a product best suited to their given audience and instructional needs. Formative evaluation was conducted on both programs (Clark, 1995; Knupfer, Barrett, & Lee, 1995). In addition, summative evaluation was conducted on the product designed for teachers (Clark, 1995). Results of the summative evaluation of the teacher's multimedia product indicate that significant differences occurred in the abilities of teachers who used this program to identify, understand, and explain specific teaching strategies they observed in the video vignettes as compared to those who did not use the multimedia.

The product designed for social workers is much more extensive; it represents a series of ten distinct topics of study that each carry three continuing education units of credit. Each topic is considered as a unique course of study and is contained in a separate, but coordinated module like one title in a series of books written by different authors but with a single series editor. Although the ten modules are designed as a set of training for social workers, the modules can be studied in any order and in any amount. The criteria for receiving credit for each module rests in completion of an on-line test with a passing grade.

The social work modules are being phased into numerous communities as the development progresses and eventually all ten modules will be in place in numerous locations. As each module of the series is developed, it goes through formative evaluation and field testing. Summative evaluation will be conducted after several modules have been placed into the social work offices in various communities. This paper limits discussion to the first module, *Child Development*, for the sake of simplicity and clarity.

Success of any product's effectiveness will be affected by the learners' acceptance or attitude toward the product, the product's match with learners' needs both in a technical sense and in terms of content, and the product's ability to be used within a given environment. Therefore any evaluation must also consider the reactions of both the social workers and preservice teachers to using the hypermedia. Results of the evaluations to date suggest some guidelines that instructional designers should consider when designing such products. Further, as we think about ways to improve those products and enhance their content and functionality with material from outside sources, such as those from the internet, we need to be able to evaluate the quality of the outside resources as well.

Interactive multimedia computer tools can expand our ways of thinking and perhaps encourage metacognition, more deeply than software that contains only standard text, few images, or non-interactive video. In interactive multimedia contexts, learners browse and search through video, images and text; form interpretive thoughts; make connections between visual text, still images, and full-motion video images; and cluster discrete fragments of information into meaningful ideas. The challenge for instructional designers is to take the set of guidelines that has been developed for interactive, computer-based instruction, and extend them to include guidelines that consider the dynamic nature of the myriad possibilities that become available with new technological tools, resources, and techniques.

As authoring tools become more transparent and more people become skilled at incorporating the internet into their work, the volume of interactive, multimediated software intended for self instruction is likely to increase. This increase signals two things: more software that is produced by novice instructional designers or people who have limited knowledge of techniques appropriate to efficient learning, and the need for guidelines to use in the production and evaluation of the hypermediated software. Such a design framework will go beyond the guidelines used for computer-based instruction as we knew it a few years ago and if not able to provide succinct answers, will need to at least address additional areas of possibilities.

Designing hypermediated instruction is a formidable process. It calls for deep analysis of many interconnected and dynamic components, and results in a set of organized activities and processes (see Andrews & Goodson, 1980, and Gustafson & Powell, 1991). One critical component of hypermediated instruction is the use of visual imagery. Knupfer has suggested guidelines for employing visual imagery within computer-based local and distance instruction that incorporate some of the well-established standards for instructional television production (1994a; 1995). There is a need to take that set of guidelines and extend it even further. In doing so, the following questions seem essential to any improvement of instructional design guidelines for interactive multimedia. Their answers help to construct a possible framework to guide future designs for hypermediated learning:

- How should the visual elements of hypermedia be structured?
- What are the proper uses of visual metaphors?
- What are the formidable questions inherent in the presentation of content and images?
- When does design supersede content?
- What is the importance of the instructional designer's familiarity with new models of instruction and learning theory?
- What theoretical elements are appropriate for the graphical-user interface?
- Are the images, language, and content free of cultural and gender bias?
- How do the images, language, and content accurately represent the cultural and gender variables?
- How should formative and summative evaluation occur?

Although there are no answers that will work in all situations, for all audiences, there are some considerations that designers can incorporate into the planning process. Further, as hypermedia takes fuller advantage of on-line resources it will be important for designers to consider strategies for handling dynamic information and images from outside sources, such as the internet.

CONSIDERATIONS

How should the visual elements of hypermedia be structured?

Visual imagery is one of the most important elements of hypermediated instruction, yet many designers fail to incorporate it to it fullest potential. If used wisely the visuals can greatly enhance the instructional message. Like other elements within the product design, visual information needs to be applied in a consistent manner yet with attention to a comfortable blend of variety and aesthetics. Both of the products evaluated for this study did an excellent job of applying visual elements to a certain extent, and both have areas in which they can be improved.

The greatest weakness of both products stemmed from the limited experience of certain key decision makers who lacked enough skill to visualize elements of the learning process. Having not been trained in instructional design, nor visual learning, nor graphic design, nor aesthetics of art and so on, some key leaders were greatly limited in their ability to imagine the potential of the visual messages within each product.

Certain weaknesses within each product, both in terms of adding time to the production and in the final visual message, were the direct result of decisions made by project leaders who did not understand how to take advantage of the medium to enhance learning, tried to save time by skipping steps in the design phase, and placed too much responsibility on programmers to provide design solutions toward the end of the development cycle. The complexity of reasons for these weaknesses are beyond the scope of this paper, but the resulting compromise in potential learning is most evident in certain mismatches between video imagery or graphics and the content or tone of the script.

There is no doubt that the single most important factor in the successful instructional design and imagery used was the result of teamwork that drew on the talents of a variety of people. Communication among the design team was essential.

Successful visualization within each of the products was the direct result of being able to work with a talented artist who was able to shape the ideas into visual form that carried meaning into the instructional process. In order to do that, the artists needed to be emersed in the design process from the beginning. They turned ideas into images that communicated visually. Their choices of shapes, colors, representations, animations, morphing, and transitions had a major influence in each of the final products. The visual elements that seem most important are those that comprise the basic structure of the image, add meaning to the message, and employ the power of visual impact when appropriate (Knupfer, 1994b).

The Structure of the Image

The structure of the image first considers the visual as a whole, then its components and the elements of good screen design. In order for the various image components to work together, elements of well-planned screen design must weave the components together in an aesthetically pleasing and understandable format. Thus, one must consider both the separate image components and the screen design as a whole.

The Image

The image contains a mix of components that can work together or separately to modify the intended message. Text, color, graphics, animation, the multimedia mix, size, special effects, and the dynamic nature of the components all will influence the message delivery and resulting interpretation.

Text. In the late 1980s, text dominated computer-based instruction (Soulier, 1988). Improved technology and attention to visual design offer the potential for more variety within the imagery, and many courseware designers have incorporated more graphics. Yet it appears that much of the information available from computer courseware and from internet resources, does not take advantage of this capability and seems to use text-intensive screens.

Analysis of the social worker's courseware revealed a strong effort at visual design. Graphics and video were incorporated throughout the courseware, yet the majority of information was contained within the text, with the imagery used for emphasis, reinforcement, or aesthetic value. Analysis of the teacher's courseware revealed that graphics were used to carry the message in certain places and to support the textual message in other places. Both the social worker's and teacher's courseware depended heavily on the audio script to support video imagery. In addition, the social work material offered the learners the ability to view the text of any audio script in addition to hearing it. None of the learners utilized this feature, yet it was left in the product to accommodate learners who might be hearing impaired or use the material in an office with environmental noises that might interfere with their ability to hear the audio. Both products incorporated volume control.

When graphics alone are used to carry the message, the graphics must be concise enough so that learners are able to understand the message. Likewise, when large amounts of text are presented, it is important to design text displays that communicate clearly to the reader. With appropriate fonts and spacing, computer screens can work very well for presenting limited amounts of text. Large amounts of text work better in printed form (Soulier, 1988) since they induce eye fatigue (Hathaway, 1984; Mourant, Lakshmanan, & Chantadisai, 1981) and are likely to be forgotten when presented on the screen (Wager & Gagne, 1988).

In addition to the amount of text, its density, along with typographic cueing and the mix of upper-case and lower-case characters can affect legibility (Hartley, 1987; Hathaway, 1984; Morrison, Ross, & O'Dell, 1988; Ross, Morrison, & O'Dell, 1988). Variations in font type, size, and density along with direction and screen placement can add meaning to the text image. With the exception of selected levels of titles and headings, or special effects, the text should contain a mix of upper and lower case letters.

The teacher's product did not contain titling and depended upon the graphics of the user interface to act as a map for the learner. For example, starting with a hallway lined with various doors, the learner would click on a doorway of a specific room and by moved into that room. From that point, the learner used objects within that room until the hallway pass was chosen to exit that room and return to the hallway. The social worker's material began by using a single level of titling, but changed to a more precise title plus subtitle system after formative evaluation revealed confusion.

No matter what the screen design, legible text requires an appropriate font that is properly spaced. There is disagreement about the appropriateness of serif or sans serif style fonts. Some authors claim that fonts with serifs, as opposed to block-style lettering, are a better choice for computer screens (Soulier, 1988). Yet others believe that sans serif fonts with proportional spacing provide a cleaner effect that is easier to read than their seriffed counterparts (Gibson & Mayta, 1992; Kemp & Dayton, 1985). Fonts with small serifs can add interest to the display, while elaborately-seriffed fonts are difficult to read, especially if the image is to be viewed on television or projected in a large room.

Text legibility also depends upon the point size of the font. The point size of text on a computer screen can range from 12 to over 100 points per inch and remain legible. However one should consider the intended usage when selecting point size. Images that are likely to be projected for large audience reading should not use a point size smaller than 26 (Gibson & Mayta, 1992) and images that are not likely to be projected or broadcast will seldom require an extremely large font. Also consider the user; when designing screens for young children or people with visual impairments, use a larger font.

In addition to style and size of the font, the weight of the typeface, line length, phrasing, and spacing between lines of text affect the legibility of computer screens (Jonassen, 1988; Morrison, Ross & O'Dell, 1988). The weight of a font can vary from light, narrow, fine lines to heavy, broad, bold lines. A medium to bold weight is very good, depending upon the mix of elements on the screen. Gibson and Mayta (1992) recommend that bold typeface be used throughout all computerized screen images that are intended for broadcast so that the text shows up against the graphics. At the least bold fonts should be used for all titles and headings as well as for particular words that need emphasis in a projected image. Bold fonts are not necessary if the image is to be viewed on a single computer screen. Medium weight fonts are quite legible if the color mix and font style are compatible. If using a small font to preset a large amount of text on an individual screen, a lighter weight font will be more legible.

Drop shadows behind the text characters can add legibility if used carefully, but they can also interfere with legibility. Therefore it is important to check legibility prior to applying drop shadows throughout the courseware.

The design of hypermedia resources must consider the effects of mixing text in a way that follows known layout practices to aid learning and retention, while attending to individual preferences, habits, and usage situations. All of this must consider mixing media in a way that allows learners to recheck information that they do not commit to memory.

Text that is designed as part of the visual imagery can add impact to the on-screen presentation. This visual text can be stagnant or dynamic and has the ability to add meaning to the message. Text can employ hotlinks to more information and color-coding to suggest meaning and serve as an aid to navigation. Although it is tempting to use flashing text as a way of getting attention or using a fancy technique, this should not be done. The flashing can interfere with the brain functions of people who are light sensitive or who have a seizure disorder.

No matter what exact techniques are used from the range of possibilities, learners seem to be more able to find their way around when the user interface is simple and consistent so learners know what to expect. Thus for text-dense sections, it is better to design screens that present categories of information concisely with links to other screens rather than presenting long scrolling screens of text. If the navigational interface includes consistent return paths following each section, then the learners can navigate with less chance of getting lost.

Color. Specific educational objectives can be enhanced by using color in visual illustrations (Dwyer, 1978), but while a few colors can cue the learner about the intended message, too many colors can be confusing. Color should assist the user in focusing on the material; it should never be a distraction (Gibson & Mayta, 1992). Accordingly, Hannafin and Peck (1988) suggest using a bright color to cue the learner for new information, while presenting the remainder of the information in standard colors consistent with the rest of the screen. Soulier (1988) recommends checking the program on a monochrome monitor and when in doubt about legibility, use a different color or employ patterns as a backup technique to aid those people who are color blind.

Color can be used as a visual cue to indicate hot words, type of multimedia activity or link, flow of information such introductory or summary sections, or as a navigational aid to highlight menu choices, content maps, and so on. Whenever possible, it is helpful to use colors in a way that does not conflict with outside materials that are likely to be incorporated as part of the instructional flow. For example, if learners will search the internet as part of the instruction, then color coding of hot links should be used in a way that is likely to be employed in those materials as well as opposed to simply choosing your color coding independently of that situation.

A few colors with good contrast values will show up well on both color or monochrome displays, but an extreme contrast like stark white on a black background will cause bleeding and illegibility; it is better to use light gray to achieve the desired effect. Also avoid high values of red and orange because they can bleed into the surrounding colors.

In addition, certain colors that look ideal on an individual computer screen tend to flare or wash out when they are projected to a large screen or transmitted over a distance. To avoid disappointment it is best to experiment with a few color combinations using the equipment that will support the image when it is actually projected. Complementary colors with low saturation would have a good chance of working.

Graphics and Animation. Graphics add interest to the screen by providing visual variety (Kemp & Dayton, 1985) and offer another opportunity to suggest meaning to the learner. There are many ways to incorporate graphics into learning, yet designers often forget to determine the instructional reasons for using graphics prior to making decisions.

Five main categories of instructional applications of graphics include cosmetic, motivational, attention-gaining, presentation, and practice (Rieber, 1994). Possible graphic treatments range from simple to complex, from small monochromatic embellishments to dramatic, richly-colored, full-motion video images complete with sound effects. Prior to deciding on uses of graphics, it is important to consider the instructional meaning of the graphic. In the social work project, this guideline was extremely difficult maintain because like many others, key people in authority positions had been fooled into thinking that dramatic visual effects translated into dramatic learning, regardless of instructional purpose.

Graphs that display data depend upon the reader's thought processing, interpretation, and comprehension; to be effective they must consider the intended visual message carefully. Sophisticated graphic displays that are designed to suggest inferences, generalizations, and evaluative interpretation can help students interpret meaning (Reinking, 1986; Singer & Donlan, 1980). High-level instructional graphics, such as symbolic, schematic, or figurative displays can be effective in teaching, and the visualization of abstract ideas through figurative displays may very well enhance learning (Nygard & Ranganathan, 1983). All graphics do not require the same level of detail and clarity, but even simple, decorative graphics at the pictorial level have their place. Indeed, Boyle (1986) suggests a need for designers to address cognitive processes by developing more materials for graphic thinkers, not just graphic readers.

The *Child Development* module contained a challenge that was nicely resolved through visual graphics. Rather than simply presenting a growth chart as a line graph, the information was displayed interactively. Two figures, one girl and one boy, were compared side by side on the screen. Learners could enter information about age, height, or weight and see visual representations that compared boys to girls at key stages of growth. The combination of interactive visualization seemed to help learners conceptualize important stages of physical development.

To assist with designing computer graphics, Soulier (1988) offers the following guidelines: keep illustrations appropriate for the audience; use simple line drawings when possible; preload graphics into the program so that they appear quickly on the screen; use standard symbols and symbolic representations; and keep graphics on the same screen in close proximity to the corresponding text message. These few tips can greatly improve the aesthetic appeal of a graphic and promote clarity of the message. Even though multimedia supports elaborate graphics with a host of detail and many colors, use care in developing those graphics so that they fit the need. Sometimes it will be important to provide near photographic quality images, but other times that is completely unnecessary and only takes up memory while slowing the program processing.

Most development software allows the use of simple animation to illustrate a motion, provide interest, or draw attention to particular areas of the screen (Kemp and Dayton, 1985). Although it is tempting to embellish the graphic, it is important to use animations only when appropriate and keep them short (Soulier, 1988).

In order for animations to be effective, there must be a need for visualization. Animate only a few graphics that will aid the learners' comprehension of the material by, for example, gaining attention, illustrating a concept, or showing direction. When used sparingly animations can be effective, but they can become irritating, distracting, or disruptive to the thought process if overused or left on too long. Whenever possible, allow the user to interrupt the animation.

Screen Design

Good screen design aids the learner by using visual components to portray the message in a way that provides both clarification of information and visual interpretation. To visually aid the learner, it is necessary to consider the specific elements of good screen design as well as the general screen layout.

Elements of Good Screen Design. Interesting screens are composed of a variety of elements that work well together. Many of these elements are equally important so they are presented here in no particular order. The goal of good screen design is to use the various elements together to compose a simple, consistent design that provides sufficient information while avoiding clutter.

Unlike printed material which can be skimmed at will, the computer screen limits the learners' view of the overall content. Screen designs that are simple, straight forward, and consistent can help lead learners through the material, while complicated designs can lead to frustration. The basic simplicity of frame layout and user options does not restrict the ability to add interest and meaning with a full range of simple and complex graphics.

The graphic user interface in the teacher's multimedia project presented a simplified view of a school. Each room contained certain information that would be familiar and suggest meaning to the learners, but extra elements were left out. Possible problems with such a graphical user interface are likely arise when the imagery or graphical metaphor presents an environment that is unfamiliar to the learners. Also, it is important to establish patterns of linkages within the graphics so that the learners know what to expect. For example, the images that contain hotlinks should be obvious to the learners. They should not have to makes guesses about which images are active and which are not active.

Certain user options should always be available. For example, status lines at the top or bottom of the screen that contain consistent information help the learner assess progress and maintain some control over the program direction. The reader should control the display rate when possible so that there is adequate time to read the text, interpret the graphics, and consider the meaning of the message. A few standard templates will aid programmers and learners. Programmers can easily update images or text if fits into a template without experiencing misalignments. If designed consistently, learners know what to expect from patterns of information and program functionality within template areas.

Menus should be clear, concise, uncluttered, and consistent. Icons within menus can be very helpful if the meaning of the icon is readily apparent. The range of possible choices in some programs can lead to cluttered or excessively layered menus; pull-down menus can be a solution. Highlighting or fading some menu choices will quickly give a visual cue about which items are currently available.

Careful positioning of text on the screen can add to its aesthetic appeal and legibility. Although centering can work for lists, diagrams, or graphic mixes, most text should be left justified and limited to 65 characters per line or 25 characters per line for projected images (Knupfer, 1994a). Partitioned screens in which text is confined to specific areas, can work very well.

Ross and Morrison (1988) suggest using a hierarchical text display that is vertical and uses indentations similar to an outline. They further recommend a low-density text display with reduced wording and sentences limited to one main idea. Also, it is important to use care when splitting lines so that phrases remain complete Soulier (1988). Personal preference varies concerning the spacing of text as long as it is legible, but do provide text breaks where the content allows. In the case of a completely graphic menu, the images should be limited to those that are necessary and should also suggest an obvious meaning. There is disagreement about whether icons should be labeled, but one compromise we can suggest is to provide labels within balloon help. The social worker's product incorporated icon labeling in that manner so that a label appeared only when the mouse passed directly over an icon.

In addition to font size, the text legibility is influenced by contrast with the background. Common considerations for both computer screens and video images suggest cool, neutral background colors like gray or blue instead of bright, very light, or very dark backgrounds. Tasteful use of enhancements such as outlined, inversed, flashing, or drop shadowed text can add to legibility. The wide variety of patterns available for backgrounds can create visual interest, but those background patterns can also interfere with the legibility of text.

Special techniques for changing the screen display, such as zooming, panning, tilting, and wiping onto the screen, can vary the viewer's perspective of the image. For example, a section of the screen can be enlarged to give a close-up view of specific details. Or the image can change from a long shot displayed in a small part of the screen to an extreme close-up showing part of the same image displayed in full screen mode. This technique can give the learner the sense of moving in to take a close look at the image. Imagine, for example, the visual effect of looking at a long shot of a group of trees in a small box on the screen and then changing to a full screen display of a close-up shot of leaf on one of those trees.

When projecting computer images to a large screen system, overscan and underscan considerations become important (Knupfer, 1994a). Overscan fills the screen beyond the edges so that no blank space will show around the edge when the image appears on a television monitor; computer graphics need to be produced in overscan mode so that no blank edges or distracting video signals will show around the edges during transmission (Gibson & Mayta, 1992). Underscan protects a blank area around the screen edge so that images don't get cut off during the transmission process; important information should be placed within a safe area, usually the middle two-thirds of the screen (Kemp, 1980). This is especially important when determining proper placement of navigational aids at the screen edges.

Both the social worker's and teacher's multimedia products in this study, were designed with for use by individual learners, but the products also needed to function for large group presentation in certain situations, so issues of text size, overscan and underscan were important. A second common problem with computer-produced screens is changes in color that emerge as the image passes through different equipment. For example, color selection might not hold up during projection, colors might appear different or even washed out on different screens. Even if it looks wonderful on the production machine, always check your images on equipment and situations available to the end users.

Screen Layout. The elements of good screen design work together to build a cohesive screen layout. The computer screen layout should never be visualized as a printed page filled with text, but guidelines similar to those offered for desktop published materials can be helpful. These include balancing text with white space, improving the aesthetics of the page, and positioning graphics as the dominant visual element (Parker, 1987). Designing the display with attention to legibility, the purpose of the particular frame, and consistent protocol, can result in visually interesting computer screens. Avoid cluttering the screen with too many images; provide print copies of complicated images that are important to remember. The social worker's project produced a workbook with text intensive and supporting materials that were best offered in print. Support material included pages about child development that could be Xeroxed and set home with parents. These worksheets would be especially valuable to parents who are tracking patterns in children suspected of having delayed physical, mental, or emotional development.

Like silence within oral communication, empty spaces can be used to advantage on the computer screen. For example the screen can be used to organize or highlight information, to draw attention to particular parts of the frame. The mix of graphics and text can provide a visual cue; so can boxing and grouping of information. Partitions, borders, standard icons, and consistent placement of common elements will visually aid the reader.

While partitions and borders can draw attention to an area, artistic sense can still flourish. Double borders or pseudo bordered areas can create an interesting effect, but use care when partitioning screens. Screens areas can help learners know where to look for certain types of information, but excessive use of boxes and boarders can also disrupt the flow of information and signal novice design skills.

Headings are often centered and bold, or sometimes even boxed. Although this is not necessary for nonbroadcast multimedia, headings should at least be used consistently. For long or complicated sequences of instruction, subheadings can be used that include numbers or roman numerals to aid the reader in visually following the general flow of information. As a general rule, information should flow from the top, left part of the screen to the bottom, right part of the screen because that is the way people in our culture read. Variations in standard layout can work if they are with purpose and fit the situation. Challenges in this area are likely to arise when incorporating information from outside sources or designing information for a wide variety of users, in a multicultural or world-wide sense. The projects in this study applied limited resources to specific and known audiences, so this did not become an issue beyond the normal attention to gender and culture within the language, imagery, and examples employed.

Good layout technique depends upon an understanding that not all computer frames are alike. Hannafin and Peck (1988) address transitional, instructional, and question frames. Transitional frames are used to tie together the different parts of the a computerized lesson: they provide an orientation to the beginning of, and various sections within, the program; they serve as bridges between various topics or sections; they provide feedback, directions, and instructions; and periodically, they present a progress report to let the learner gauge success. Instructional frames present basic information to the learner: these frames can alert the student to a need for prerequisite information; provide links between relationships from past and current learning; and provide definitions, examples, and rules. Question or criterion frames solicit input from the student to help individualize the instruction; these frames usually are based upon a true or false, yes or no, multiple choice, completion or short answer, or a constructed response which is considered to be a more open-ended answer.

There are also variations to the general type of frames. For example, sometimes a frame contains both instruction and a question. Copy frames, prompt frames, hint frames, and interlaced frames are some types of variations (Hannafin &

Peck, 1988). Copy frames provide information and a question about that information in the same screen. This type of format can be helpful in directing student attention, emphasizing important points, and for assuring a high degree of success for particular students. But because they are so obvious, copy frames are considered very elementary and need to be used sparingly.

Prompt frames direct the learner to supply input; these can be used effectively for questions as well as instructional screens. Hint frames are usually provided after a student has failed to enter an expected response; they offer guidance but do not supply the correct response. Interlaced frames are hybrids which combine various components from the standard frame types; they might include instruction, question, and feedback all on the same screen. This design can appear cluttered if not presented carefully but it has the advantage of allowing the student to visually examine and compare the question and feedback.

Each type of frame depends upon grouping of information in a way that visually aids the reader. To make optimal use of visual cues, it is helpful to design standard protocol for each type of frame and use it consistently throughout the program. Whatever protocol is chosen will need to comply with the overall program design. Programs that vary the screen location of pertinent information or procedures used to advance throughout the program can be confusing and frustrating (Mackey and Slesnick, 1982). Although standard protocol is necessary (Apple, 1992; Heines, 1984; Jonassen, 1991; Lentz, 1985; Simpson, 1984) designers can provide artistic variation to other parts of the screen to suggest meaning.

The Meaning of the Image

Information becomes valuable as it takes on meaning for an individual. Since visuals are meant to aid in the discovery of meaning, it follows that well-designed visuals will help students interpret the meaning. Computer images vary widely in potential design and usage. Images can be static or dynamic, concrete or abstract, and they can change as a result of user interaction with the program. A learner's interpretation of the image can be affected by the text, type of graphic, and layout employed.

Layout must consider the principles of perceptual organization, which include similarity, proximity, continuity, and closure (Bloomer, 1976). These four processes, by which the mind organizes meaning, depend on how physically close the objects are, how similar they are, whether there is a continuous line to guide the eye, and whether the minimal amount of information is present that is necessary to obtain meaning or closure. Comprehension is directly affected by the way the mind organizes meaning from the placement of graphics and text (Norman, 1993) and in the process of linking information.

The Power of the Image

Computer graphics and appropriate screen displays can lend power to communications by adding vivid imagery to the text. Visual images can aid message interpretation and enhance learning. They can also add power to the message by providing an emotional element that is beyond that of other communication strategies. Realism can be enhanced by providing a graphic component. Images can represent realistic data ranging from simple sketches or graphs to intricate displays or vividly emotional scenes. Virtual reality can even conjure up imaginary situations through artificial imagery.

Brenda Laurel compares computer programs to theatrical plays and describes several similarities between the two (1993). Although computer programs can allow different paths to completion, they are similar to plays in that they should have a beginning, middle, and end. In addition, both can provoke emotions.

Emotional impact can be added to hypermedia by using graphics that evoke feelings or encourage learners to imagine certain situations. Size, color, shape, dynamic images, and special effects can be employed to evoke emotions, but it is wise to use a conservative approach and not overdue these techniques.

Hypermedia can display still or dynamic photos of real or imaginary events. These events and their results can combine with text and audio segments to provide a sense of realism to the user that otherwise would not be possible. The *Child Development* product evoked emotional impact by showing still and motion images of children in real situations of school, play, homes, and hospital settings. The teacher's product showed real classroom scenarios. Along with the understanding provided by the realism of these events, comes the potential to stir emotions for various reasons.

What are the proper uses of visual metaphors?

Like verbal metaphors, visual metaphors can help us to understand an unfamiliar concept. Metaphoric graphics (Soulier, 1988) may be used to clarify a meaning within the computerized message, or they can guide the user through the mechanics or functionality of using the software. For example, standard male and female icons represent content in the growth chart portion of the *Child Development* product while an exit sign icon symbolizes the functionality of both products. Both products in this study used a typical "VCR" control panel to manipulate viewing of the video clips.

Metaphors are only as good as a situation allows. Metaphors can work well in a variety of situations, but in all cases must provide an appropriate match between the topic, the learners, and the way the metaphor is applied to the design. If learners cannot relate to the metaphor, then the instructional message will be lost. But if they can relate to the metaphor, then the instructional message can be enhanced.

Metaphors are used to some degree in both the social work and the teaching multimedia projects, but they are applied with differing intensities. The social work project incorporates a variety of limited metaphors into the modules, but does not place heavy emphasis on does not carry any one, single metaphor throughout the entire series other than in the overall functionality of the user interface. For example the legal module was developed by different design team members and contains different metaphors than the stress module, yet the general functionality of the user interface remains consistent.

The metaphor within the teacher multimedia worked well with the student teachers it was intended to be used with, but other learning audiences have reacted with confusion and frustration . Objections to the completely graphic interface arose because some learners could not relate to the school scenario, needed more preliminary interpretation of the graphical user interface, or preferred environments that were more text-based. General comments about desiring more text indicated some potential for confusion with interpreting the school metaphor as well as unclear functionality of each graphic. Learner who are willing to explore will probably feel more comfortable in this type of environment.

What are the formidable questions inherent in the presentation of the content and images?

How many links per screen are appropriate? The number of text links per screen can become quite dense, depending upon the situation at hand. When there is information that is critical to the instruction, designers need to weigh the consequences of allowing learners to explore branches of that information in-depth or finding extraneous information versus concentrating on a limited amount of critical information.. We found that time and concentration efforts were limited in both the social work and teacher subjects who used these products, so they choose to get through the instruction in the quickest way possible, ignoring many links.

The number of links per screen certainly will depend upon the purpose of the instruction, the audience involved, time available, consequences of learning more or less information about the topic, and whether the links confound or enhance the potential learning. It appears that a screen can have numerous links as long as there is an obvious way to return that screen, to exit a link that is erroneously chosen, to indicate which paths have already been taken, and to aesthetically work the links into the screen without adding clutter that distracts from the main flow of information.

The balance of images per screen will not be determined by a precise definition, but will depend upon the purpose of the imagery, the balance of the screen design, and the functionality of the images. It is perhaps better to design one complex but integrated set of images as opposed to independent, cluttered, or conflicting images. In addition, the meaning of the images is important. All images should fulfill a specific purpose. That purpose might be to get attention, enhance meaning, make a powerful statement, add variety, and so on, but it clearly should not be simply to fill a blank space on the screen.

The length of the video vignettes was a topic of debate with both of the projects at hand. While the vignettes need to be long enough to provide meaningful scenarios that portray information clearly, they need to be short enough to allow user interaction, practice, and feedback at appropriate places. Large amounts of video information can be incorporated as smaller video clips as long as there is a common thread that laces the information together and promotes interaction that helps learners make the cognitive link between pieces. If video is shown in smaller clips, the challenge becomes one of determining proper entry and exit solutions. Transitions become very important yet need to accommodate learners in a hypermediated context, not in a linear sense. Novices on our projects had difficulty designing a product with a beginning, middle, and end that is was not linear.

When does design supersede content?

Some people might say *never*, but there are times when the design needs to supersede content. Courseware must show consistency within the user interface, so once a design standard is decided upon it must be maintained in a similar manner throughout the instruction. In addition, designers need to be aware of standards and common practices that have been incorporated into other software that the learners have used in the past. If learners expect the software to function in specific ways, then it is best to incorporate standard practices when possible so that learners can concentrate on the content and not be confused by inconsistencies of functionality.

In a case where the instruction is designed as a series of modules, learners expect one module to function in a similar manner as another. Like a series of books in a set, learners expect certain consistencies within the look, feel, tone, instructional approach, and functionality of the courseware.

When content can be delivered in a variety of ways, design can determine final decisions about how content is delivered and how much detail is appropriate. Because hypertext allows hotlinks to be made, designers are not pressed to include all details about a subject within the main part of the courseware, but can use links to outside resources as necessary, thus enabling learners to choose more or less detail, depending on how much information they need about specific topics and how much time they can spend at the given moment.

Screen design enters into consideration as well. Good screen design allows adequate white space so that the eye has a resting place and incorporates imagery in a meaningful way. Rather than filling the screen with text, designers often need to reword and abbreviate text so that it fits well within the visual design of the screen and in so doing, need to consider grouping of words, phrases, and lists in the best way to enhance the mental processes. Substituting imagery for text can add power to the message.

Product design should to meet the needs of the intended audience. Products need to fit within the intended learning environment in numerous ways and in so doing, consider the hardware available, the physical work environment, and the emotional state of the learners. The best products will fall short of intended results if people need to struggle with hardware, can't hear the audio, can't fit instructional sequences into available timeframes, and so on.

The audience might expect media to contain special effects like they see at the movies or on television. The maturity of the audience could very well be a factor in this regard and should be considered. It will be important to use special effects wisely so that they add to the purpose of the instruction.

What is the importance of the instructional designer's familiarity with new models of instruction and learning theory?

Design team members debated about whether the same instructional approach could be used for everyone who will use the courseware. If not, then how could the designers accommodated different learning styles within the courseware?

Like other types of instruction, hypermediated instruction can provide examples, practice exercises, and feedback that will use a variety of instructional techniques and appeal to different styles of learning. As hypermedia becomes more sophisticated and gains capability of incorporating outside resources, designers can leave more discretion to user preferences. It remains a challenge to design for the type of cognitive processing allowed by hypertext while including some sound design practice from standard computer-based instruction. Even though hypermedia links and standard computer-based instruction seem to approach design in opposite ways, cognitive interpretations of instructional design reveal many similarities (Jonassen, 1991).

It will be important that designers break free of behaviorist models to the extent that the courseware does not rely so much on that approach. Hypermedia allows a much more creative approach to instruction than the drill and practice style of learning, so designers can incorporate more constructivist approaches to courseware design and student evaluation.

Designers can do such things as provide more choices within the user interface. Those choices could allow learners to move in different paths through the material and incorporate more or less information into the lesson as needed. In addition, learners should not be forced to listen to audio or to read text verbatim at all times, but should be allowed choices to hear, read, or hear while reading text in specific situations within the learning. Thus learners can choose to receive information in a way that is most comfortable at a given time.

Expectations for the potential of hypermedia are high, yet learners in both the social worker's and teacher's products experienced a certain level of disorientation and they tended not to use fancy features and graphic links. This raises questions about the need to prepare learners to better use hypermedia and to better read visual imagery.

What theoretical elements are appropriate for the graphical-user interface?

It is important to match the instructional design to the situation at hand. This means considering the goals of the instruction, the needs of the learners, the environment, and so on. While doing so, designers must ask whether situated-learning metaphors are appropriate to the audience and the content. If so, what situations are suggested or accommodated?

Another question that is important to answer in the design phase is how the learning is expected to be constructed. What design elements related to learning theory should be evident within the courseware? Is there evidence of learner control and autonomy, or is the program designed in a more behavioristic, directed structure?

How does guided learning fit into the courseware? Is learning guided in a systematic way, a tightly controlled way, not at all, or something in between? What evidence is there of motivating learners and attending to various learning theories? Does there seem to be a match between the courseware's purpose, the audience, skill level, and instructional approach? How does the system work together as a whole?

The new hypermediated courseware could incorporate information from outside sources that the designer cannot determine or control. For example, learners could potentially go to certain pages in the World Wide Web (WWW) to get information. The problem here for instructional designers will be the dynamic nature of such material; it could be here today and gone tomorrow, or changed tomorrow. If WWW resources are incorporated, how will it be managed?

As more sophisticated graphics are incorporated, it will be important to determine how to manage the complexity created by the imagery. How much importance can be placed on a learner's ability to read visual imagery? What things can we do to enhance visual literacy? How will windowing inhibit or enhance learning? Will windowing serve as a way of separating information visually or will it interfere with the flow of thought? In what ways can visual text and visual graphics help learners maintain a sense of direction as they move through various links?

There are many questions that lead good instructional design efforts. Although there are no set answers to all of these questions, instructional designers can at least address the questions to determine what guidelines will lead the design efforts.

Are the images, language, and content free of cultural and gender bias?

Media often portrays people in stereotypical roles. Movies, television programs, advertising, books, and now even clip art are fraught with stereotypes based upon cultural background, race, and gender (Binns & Branch, 1995; Couch, 1995). As courseware developers think about designing, scanning, or downloading images into the courseware, they should consider what messages are implied by the images.

Are the men portrayed in leadership positions, while the women appear in subordinate roles? Are men portrayed in work situations or using technology, while women are portrayed in nurturing roles? Are women portrayed as either older and overly-grandmotherly, or young and overly-sexy?

Are colors and tone used to add feeling or draw attention to an image in a suggestive way that might bias the learners? Examples of this are the darkening of O. J. Simpson's face on the cover of Time magazine (1994) and the bright red coloration applied to the woman figure's nipples in an otherwise dark and muted image depicting a male and female within a recent New York Times (1996) report on cancer. The former suggests a guilty verdict prior to the trial while the latter continues the American male fixation on women's breasts as sexual objects, even within an article focused on medical education.

Do sports analogies or competition appeal more to males than females. Are cultural groups represented in true proportions and in accurate situations with the examples, imagery, and prerequisite knowledge necessary for successful completion? Can the courseware be used in different cultures without bias? This question raises issues of cultural sanitation versus lack of bias; where is the line drawn?

How do the images, language, and content accurately represent the cultural and gender variables?

This question goes deeper into the underlying messages portrayed through the images, language, and content. Rather than simply avoiding stereotypes, it is important to keep the messages in proper context in terms of culture and gender. For example, does the design go the extra step to consider and include examples from the cultural group that the courseware will be used with? Certain examples will make better sense if the learners can relate to them.

Messages intended to influence attitudes toward using birth control and planned parenting, need to consider the cultural underpinnings of such issues as within the learning group. In cultures where a people's status is influenced by the number or gender of their of children, any attempt to curb birth rates would need a very sensitive approach. Likewise, portraying value systems of rural American within inner city schools and vice versa, could make the instruction fall flat.

Icons and symbology can be problematic. While some icons and symbols are interpreted with similar meanings, others will take on different meanings within different international audiences. A dragon, for example, is thought of as a scary and evil presence in Western culture, while it is believed to be powerful and even protective in Eastern cultures.

both the social worker's and teacher's products were designed to be used in American, multicultural situations. The social work product contained examples form both rural and urban situations to allow more flexibility in meaningful usage.

How should formative and summative evaluation occur?

The main questions here include the logistics of conducting formative and summative evaluation in a way that produces valid results, questions about how the visual elements actually enhance the learning, and determining what questions regarding visually literate learners are appropriate in formative and summative evaluations. The evaluation processes for both products in this study included written questionnaires, interviews, pretests and posttests, and observations. Yet the evaluations to date raise addition questions about hypermedia design.

Prior to designing the courseware, it will be important to determine what is important at the evaluation phases. What will be considered successful and what will be considered problematic? How should the visual elements be evaluated? How will designers determine the quality of the use of such things as color and contrast, or whether the design of the user interface and examples are appropriate to the content? Certainly it will be important to consider the instructional goals, the audience, and the situation in order to answer these questions.

In addition, how are the functions of the courseware evaluated? What will determine success when measuring links with other images and text? What changes are expected in images to enhance the learning? For example, will there be visual cues such as a color change to indicate that a section has been completed so that learners will be able to determine their position within the user interface?

What questions regarding visually literate learners are appropriate in formative and summative evaluations? What is the best way to determine learner understanding of the importance of the image or video to the content? How can an evaluator determine a learner's ability to "read" the image or video in context with the text and other elements in the graphical-user interface? What standard will determine the learners' acceptance level and comfort with the graphical-user interface?

All of these questions are difficult to answer because they depend on specific situations at hand. Even though hypermedia employs new techniques and holds the potential to incorporate dynamic resources from the internet, a good deal of design and evaluation standards carry on from current practice. It will be important to note where differences are important to learning while designing for the new hypermedia enhancements and plan to work within a framework that accommodates them as well.

In addition, the hypermedia links create an element of possibility that takes the learning process into a different dimension, thus calling upon different ways of learning, using different strategies and different ways of moving between topics. Designers can no longer simply assume that learners will move through topics in any given order, but must allow them to move around more freely. This implies designing information in smaller, more independent sections, that cannot depend on sequence nor amount of information covered to be considered complete. Designers will need to find ways to allow learners to enter and exit software with ease enough to accommodate the hypermedia, while attending to the completion of cognitive processing of chunks of information that belong together.

Understanding and emotional impact can be enhanced through powerful computer imagery. The imagery can represent real situations or it can create an artificial situation that appears to be real. Hypermedia has tremendous potential in terms of visual communications and educational impact, yet we have just begun to find ways to design courseware that takes advantage of some of that potential. Continued evaluation is need to examine learner's beliefs about their success with learning in hypermediated environments. There is a need to look not only at the way that instructional designers use graphical interfaces to produce hypermediated courseware, but also the way that students employ the graphics and spatial organization to construct meaning or knowledge.

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Title:

Inhibitions Within Idea Generating Groups: An Alternative Method of Brainstorming

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Introduction

Alex F. Osborn's group brainstorming treatment (1953) remains the most frequently applied and instructed procedure for the creative generation of ideas despite considerable evidence that demonstrates its ineffectiveness. It is a remarkable contradiction between a popular technique and a body of non-supportive research evidence which is based on numerous replications (over 20) of the classic experiment by Taylor, Berry, and Block (1957), and which demonstrates that individuals working alone consistently produce nearly twice as many ideas as members working in groups. Thus, group brainstorming also becomes an intriguing example of a problem solving scenario where groups apparently do not out-perform individuals.

Among the explanations for inferior group performance is the effect of "group inhibition" which was originally proposed by Dunette, Campbell and Jastaad (1963). Various other experiments provide evidence that there exist many factors which can inhibit group performance and they have been tied together into a construct called "group effects". Of the many "group effects" that have been postulated by researchers, six effects have demonstrated empirical evidence of their negative effect on a group's idea production: status in the group, social loafing, task involvement, cognitive inertia, self-oriented needs, and communications apprehension (Thornburg, 1991).

Bouchard (1969) and Jablin (1977) provide evidence that test scores on the California Psychological Inventory (CPI) and the Personal Report of Communication Apprehension (PRCA), consistently relate to individual performance within groups. Individuals with low scores on these scales consistently evidence high productivity in groups and can be categorized as "Low Communication Apprehensives". Conversely, individuals with high scores on the PRCA demonstrate low productivity in groups and can be categorized as "High Communication Apprehensives". Jablin's study demonstrated that "Low Apprehensives" (LA) consistently produce more ideas in groups than do "High Apprehensives" (HA), and that HA individuals performed best when working alone. However, group composition based on communication apprehension is a factor that is frequently omitted yet evidences a negative effect on overall group productivity, as well as individual learning and satisfaction.

Another negative influence on the generation of ideas is the effect of the original brainstorming treatment itself, which places an emphasis on the group process. Diehl and Stroebe (1991) examined group communication processes and found that "production blocking" is the primary cause of low idea generation by groups. "Production blocking" is caused by the normal group convention of waiting until other members have stopped talking before they can report an idea that has occurred to them. This appears to block the production of new ideas and may be caused by limitations of short-term memory, rehearsal time, cognitive distraction or cognitive overload. Because these communication "blocks" are present in any brainstorming activity, or any group discussions, their findings have lead them to the "emphatic conclusion ... that group sessions should not be used to generate ideas".

However, there also exists evidence that the appropriate use of group interactions, as a social processing period that causes cognitive arousal, does promote increased idea generation. Studies by Dunette et. al.(1963) and Andre et al.(1979), both discovered that individual brainstorming sessions became more productive when they followed a group brainstorming session. These studies demonstrated that the group process is a stimulating catalyst for the subsequent individual activity. Diehl and Stroebe propose that an individual session preceding the group brainstorming session would allow time to cognitively rehearse the development of ideas and might counter the effects of production blocking. Furthermore, the results of the studies by Bouchard and Jablin indicate that certain individuals with the personality trait of communication apprehension will perform better when allowed to work individually.

The IGP (Individual Orientation-Group Interactions-Personal Reflection) has been developed by the author as an alternative treatment for brainstorming, which combines the benefits of personal cognition and individualized creative thinking with the social stimulation of group interactions. The IGP is based on an instructional design that provides a methodology to overcome group inhibitions, assure individual expression, and promote divergent thinking. The IGP is a three step process, which differs from other brainstorming methods by structuring an individual session both before and after the group brainstorming activity. The individual sessions preceding the group session should allow for cognitive rehearsal and orientation to alleviate the effect of "production blocking". The succeeding group activity will allow for social interactions and an exchange of ideas which may serve as a "cognitive" stimulus for further processing during the final individual session. This final individual session should provide an opportunity for personal reflection and integration free from perceived "group effects", while also accommodating to the proven productivity of idea generation as an individual activity. Furthermore, the emphasis placed on individual sessions should be more comfortable and productive for "High Apprehensive" when working in groups.

Purpose and Hypothesis

This research synthesizes many findings that challenge the premise that Osborn's traditional " group" brainstorming treatment is the optimal method for the generation of creative ideas. The purpose of this study is to investigate if an alternative form of group brainstorming, the IGP, will facilitate a higher total production of ideas in learning groups. One factor that will be investigated is the personal communication apprehension level of the participants, which will be used to group the subjects as Low or High apprehensives. These homogenous groupings, in accordance to communication apprehension, will be examined for the effect that is caused by two brainstorming treatments: Traditional group brainstorming (Osborn) and the IGP brainstorming. Because the IGP places a greater emphasis on individual brainstroming rather than group brainstorming sessions, the IGP should evidence the effect of increasing the productivity of "High Apprehensive" individuals. The IGP treatment should not evidence any significant effect on "Low Apprehensives", because there is a period of group interaction, and overall the nominal (individualized) condition has proven to be more productive.

H1: Learning groups using the IGP brainstorming method will produce a higher total amount of ideas than groups participating in the traditional brainstorming method

H2: "High Apprehensive" individuals will produce an increased number of ideas using the IGP brainstorming method than will "High Apprehensive" individuals participating in the traditional brainstorming method.

Literature Review

Group Effect

Beginning with Alex Osborn's original version of his popular book, Applied Imagination: Principles and Procedures of Creative Thinking (1953), his process of group brainstorming continues to be the technique which is most frequently applied for the generation of creative ideas. Because it is believed to generate a diversity of solutions to problem-solving situations, Osborn's group brainstorming is also commonly implemented to initiate many group decision making processes. The popularization of this method is based on early laboratory studies at the University of Buffalo's Creative Problem Solving Institute which provided strong support for Osborn's claims that : "the average person can think up to about twice as many ideas when working in a group than when working alone".

With the continued interest in the processes of creativity, innovative thinking, or the formulation of challenging ideas and solutions, Osborn's brainstorming technique has important implications for learning groups. Does this method of group brainstorming offer the most effective method to promote the expression of a diversity of ideas and individual perspectives? Does this process nurture the potential for divergent as opposed to convergent thinking?

Osborn created his brainstorming procedure as a method to overcome what he believed was the primary group inhibition, public disclosure and the fear of potential group censorship. He suspected the premature evaluation of ideas and critical judgments caused a fear of social acceptance. These apprehensions blocked the free-flow of ideas, which Osborn felt is the fundamental process for unique and creative ideation. Osborn believed that a key component of the creative process is the unrestrained generation of a quantity or "fluency" of ideas. Therefore, a major purpose of Osborn's brainstorming technique was to overcome "group inhibitions" by creating a risk-free environment which valued the fluid expression of ideas with no fear of censorship. "The average group can produce nearly ten times as many ideas. in the same length of time, when ideation is unhampered as when judgment is allowed concurrently to interfere". Thus, group inhibitions which are caused by the early evaluation of ideas are the fundamental reason for his four basic rules to successful brainstorming:

1. Judicial judgment is ruled out. Criticism of ideas must be withheld until later.
2. "Free-Wheeling" is welcomed. The wilder the ideas the better; it is easier to tame down than to think up.
3. Quantity is wanted. The greater the number of ideas, the more likelihood of winners.
4. Combination and improvement are sought. In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into better ideas; or how two or more ideas can be joined into still another idea ("Hitch-hiking").

Osborn's claims were first challenged in a landmark study by Taylor, Berry and Block (1957) who conducted an experiment for the Department of Naval Research in conjunction with the Department of Psychology at Yale University. In this study, the total amount of unreplicated ideas produced by "real" interacting groups comprised of four members, is compared to the total productivity, or "ideation fluency", of four individuals who are designated as a "nominal" group.

Nominal groups are composed of individuals who work alone to generate ideas about the same problem, and are then randomly assigned to a "nominal" group. The nominal group's performance is measured as the sum total of unique ideas generated by each individual group member and is "scored as though the members had worked together". Taylor et al concluded that:

> The performance of the twelve real groups is markedly inferior to that of the twelve nominal groups in terms of ideas produced and in terms of unique ideas produced....To the extent that the results of the present experiment can be generalized, it must be concluded that group participation when using brainstorming inhibits creative thinking.

The authors postulated that these results were the product of the group inhibitions that Osborn sought to overcome, and that despite his "rules" to prevent the preliminary criticisms of ideas:

> Nevertheless it appears probable that the individual working in a group feels less free of possible criticism by others even when such criticism is not expressed at the time than does the individual working alone. To the extent that this is true, group participation will be inhibiting. Group participation may reduce the number of effective ideas for a second reason. A given number of individuals working in a group appear more likely to pursue the same train of thought - to have the same set or the same approach to the problem - than do the same number of individuals working alone. (Taylor, Berry and Block, 1957)

Dunette, Campbell and Jastaad (1963) replicated the experiment by Taylor et al and included in their treatment that all subjects would participate in both individual and group brainstorming sessions. Their results supported the claims of the Taylor study, finding that : "Of the 24 groups, only one failed to produce more ideas under the individual condition than under the group condition" and "Only 5 of the 48 research subjects failed to produce more ideas when working individually than when participating in a group." They further stated that four persons working individually would produce 30% more ideas than individuals working together in an interacting group. Dunette et. al. concurred with the Taylor study's explanation that groups tend to "fall in a rut" and members tend to pursue a similar train of thought which results in a convergence of ideas. This conformity to a group norm, or "group-think", negates the potential productivity that stems from the diversity of individual perspectives. Dunette, Campbell and Jastaad also noted that group inhibitions cause certain individuals, who were highly productive when working alone, to have a drastic decline in productivity when working in a group condition. This led them to the conclusion that despite Osborn's rules to prevent idea discrimination through criticism:

> It appears, however, that group participation still contains certain inhibitory influences which are not easily dissipated. The "best bet" for creative thinking in attacking problems seems, therefore, to be the pooled individual efforts of many people with perhaps an initial group session to serve simply as a warm up to their (individual) efforts.
>
> (Dunette, Campbell and Jastaad, 1963)

Numerous other studies have continuously replicated the results of the studies by Taylor et. al. and Dunette et. al., evidencing that individuals consistently outperform groups at generating ideas: Vroom, V., Grant, L., and Cotton, T. (1969); Bouchard (1969); Bouchard, T. and Hare, M (1970); Street, W. (1974); Jablin, F., Seibold, D., and Sorenson, R. (1977); and Andre. M., Schumer, H., and Whitaker, P. (1979). This collection of research results supports the proposition that there does exist some "group effect". Actually, the very premise of Osborn's original brainstorming rules are based on his supposition that the group effect of public evaluation, through intra-group criticism, is a prevalent group condition and indeed inhibiting. However, these other studies indicate that despite Osborn's attempts to create a risk free and value free environment, some group inhibitory effect remained.

Bouchard (1969) continued this trail of investigations to identify this "group effect" by examining the communications apprehension levels of individuals participating in group brainstorming. "One should not forget the very strong possibility that personality type may interact with both problem-type and group-problem-solving procedure." He began one of his series of experiments by administering the California Personality Inventory (CPI) in order to examine the relationship between scores on this measure and performance in group ideation situations.

Bouchard concluded that one scale, Sociability, and one factor, Interpersonal Effectiveness, consistently related to group performance. He found that this factor was "fittingly enough developed to predict social participation" and "Thus there is no question that Interpersonal Effectiveness is a powerful predictor of problem-solving effectiveness in small groups." Through a factor analysis, Bouchard found a significant relationship of r=.89 between individuals who are highly productive at idea generation in a group situation, and who also have high scores on the CPI's Sociability scale. This agreement is in accordance with the CPI developer, Harrison Gough's characterization of high scorers on the Sociability scale as being: "outgoing, enterprising, and ingenious, as being competitive and forward, and as original and fluent in thought." Subjects with high scores on the CPI could be described as "Low Apprehensive" in regards to group interactions and are very productive group brainstormers. Bouchard provides this description of those individuals:

> High scoring subjects in the brainstorming groups have well developed social skills, are outgoing, enterprising, original, verbally fluent, fluent in thought, somewhat aggressive, dominant, and controlling, yet concerned with feelings of others. They possess self-assurance, and are spontaneous, expressive, and enthusiastic. (Bouchard, 1969)

Bouchard believed that individual personality variables must be taken into account when seeking predictions or establishing groupings of individuals. Consideration must be given to the fact that the social interactions of a group process will effect individuals differently, and this is dependent on the personal characteristics of Sociability and communication apprehension. He concluded that the group interactions between individuals of discrete communication apprehension levels, as indicated by differential CPI scores, was a significant "group effect" that could explain the reduction of a group's total ideation productivity (fluency).

Jablin, F., Seibold, D., and Sorenson, R. (1977) continued Bouchard's investigation into personal communications apprehension as being an appropriate predictor of individual proficiency/potential in subsequent group brainstorming ideation. They administered McCroskey's Personal Report of Communications Apprehension (PRCA) as a pre-test measure of each individual subject's verbal communication level. This study confirmed an earlier study by Japlin and Sussman (1976) and indicated that the PRCA had a high correlation with the CPI (r=.68). It also validated Bouchard's previous results and his inference that groupings according to levels of communication apprehension would result in significantly different scores, based on the total number of ideas produced by the group.

Japlin et.al., created homogenous groups of Low Apprehensives (LA) and High Apprehensives (HA) in accordance to scores on the PRCA. The other factor was the condition of grouping subjects into history (experience working together as a group), ad hoc (newly formed homogenous groups), or nominal groups. Their results indicate that in every condition the homogenous groups of Low Apprehensives produce more ideas than the homogenous groups composed of High Apprehensives. The fact that this is a group effect is supported by results that show no significant difference between LAs and HAs when measuring idea production in a nominal group condition. In this condition, individuals work alone and thus there is no effect caused by group inhibitions, therefore High Apprehensives should perform better in nominal groups than in interacting groups. In fact, the results of this experiment do show that HAs performed best when working alone, in the "nominal" condition. LAs (high in sociability) appear to do best in an interactive condition, and they evidenced a slight decline in idea generation while in this same, "nominal", or individualized condition.

This study also provided an important profile of High Apprehensive individuals, which served as an adjunct to Bouchard's profile of Low Apprehensives. High Apprehensives will perform best in situations where there is little demand placed on oral communication and participation. High Apprehensives can be described as tending to participate less in group discussions and having little trust in the communicative behavior of others. They normally shun competitive transactions and are generally not effective in social relationships. In social situations they are apologetic about their ideas and prefer writing to oral communication. In general: "the individual who is high in communication apprehension is one for whom the negative consequences attached to participating in an oral interchange outweigh any perceived gains".

Japlin et.al. provided additional information to support the premise that participation in a group brainstorming session will effect individuals differently in accordance to their level of Sociability or communication apprehension. It also supports the theory of a "group effect", which is manifested by reducing the productivity of HA individuals who are effected by the condition of working in a group. Japlin et. al. consistently found that High Apprehensives performed better in a nominal (individual) brainstorming condition and Low Apprehensives performed best in an interacting condition. These results suggest that how well an individual performs in a group brainstorming session appears dependent upon one's predisposition toward group interactions. The "group effect" will have a differential effect, depending on each individual's trait of communications apprehension, which will effect their capability to perform in a group condition. This lead Japlin et. al. to the conclusion that one factor that effects group brainstorming performance is a "personality characteristic":

> Effective group brainstormers tend to be high in Sociability, low on Communications Apprehension and generally effective in interpersonal interactions. To the extent that these traits are missing in group brainstorming, members' performance may be inferior to working alone. (Japlin and Seibold, 1978)

Brainstorming Treatment

There have been numerous other studies which have investigated the possible sources of a "group effect". Street (1974) concurred with Taylor et. al. that despite Osborn's brainstorming rules to prevent the critical evaluation of ideas until later, individuals appear to exhibit a "fear of social chastisement" by the other group members. "In interacting groups, members censor their contributions because they fear possible social disapproval by the other group members." Vroom, Grant, and Cotton (1969) further confirmed the assumptions by Taylor et. al. and Dunette et. al., that the range of different ideas in a brainstorming group appears to be limited by the "motivational pressure to conform". Nominal groups consistently produce more unique, diverse and creative ideas than do interacting groups. Vroom and colleagues interpreted these findings as an indication that: " interaction tends to result in members developing a common set in their approach to the problem, which is suggestive of 'cognitive inertia'."

Lamm and Trommsdorf (1973) continued investigations into the "group effect" and identified "production blocking" as another important aspect of this overall effect. Their findings lead them to the conclusion that: "the most important source of the inferiority of groups....is the operation of the implicit rule that only one member of the group speaks at a time". This causes a reduction in overall group productivity because "the production time theoretically available to each group member of a four-man group would be one-fourth of that available under the individual conditions."

Recent investigations by Diehl and Stroebe (1991) have advanced the investigation of "production blocking". They conducted a series of experiments which compare the difference between three "group effects" identified by previous research as being: free riding (social loafing), evaluation apprehension (fear of chastisement), and production blocking. The analysis of these experiments lead them to the conclusion that the effect of "production blocking" is the most significant influence on group performance.

Production blocking is caused by the dynamics of group interactions which causes interference with an individual's cognitive processes. The fact that another individual in the group is expressing his/her ideas often means that other group members have to "wait their turn" before they can express their thoughts. Diehl and Stroebe felt that "production blocking" effects a group member's productivity, because this "delay" in the process causes individuals to devote their short-term memory to "cognitive rehearsal" of their own ideas. Therefore, in order to prevent themselves from forgetting their own ideas while "waiting their turn", group members invest most of their cognitive energies into remembering those ideas which they previously created. This prevents them from developing new ideas because: "After all, storage space in short term memory is fairly limited, and individuals will only be able to store a small number of ideas at a given time." (Diehl and Stroebe, 1987)

Indeed, Diehl and Stroebe (1991) found the production blocking effect to account for 96% of the total variance in idea generation. They found that: "When subjects were able to report their ideas as soon as they occurred, they produced approximately twice as many ideas as when they had to wait for other speakers to finish talking."

The authors also felt that the exposure to other group member's ideas caused a "distraction-conflict" which prevented individuals from devoting cognitive energy toward the development of new, alternative ideas. Instead, mental cognition becomes devoted to understanding and interpreting the ideas of others in the group. If group members are listening to others, and simultaneously trying to take advantage of the waiting time as an opportunity to create new ideas, the resulting distraction causes "cognitive overload". Diehl and Stroebe found that providing group members with a notepad to externally store their ideas is a helpful memory adjunct. However, because the very nature of group dynamics (listening to other ideas/generating new ideas) still cause a "distraction-conflict", they recommend that: "it might be more helpful to ask subjects to develop their (written) ideas in individual sessions" before entering the group condition.

Dunette, Campbell and Jastaad (1963) found that group participation appeared to provide: "the important function of a 'warm-up' for subsequent brainstorming activity". They believed there is an important motivational aspect to group participation which is caused by social interactions and social processing. The group dynamics of exchanging perspectives causes cognitive arousal and increased stimulation, while the very act of group participation causes increased intrinsic motivation. Their research indicates that individuals produced more information when the "group stimulation" is followed by a focused individual brainstorming session.

> A larger number of ideas or solutions was produced when subjects experienced the individual brainstorming after having experienced the group session, than when they "went in cold" to the individual session.
>
> (Dunette, Campbell and Jastaad, 1963)

Andre, Schumer and Whitaker (1979) also found that subjects in their experiment produced more ideas when the group brainstorming preceded an individual session. Their results suggest that: "while group experience inhibits creativity for discussed items it may serve as a spur to individual creativity for subsequent items." They believe that this is caused by a "lowering of the psychological barriers" in the individual by exposing them to the "wild ideas of other group members". This, in effect, lowers the threshold of expected social chastisement and provides a safer atmosphere for individual creativity. A group norm becomes established that allows individuals to be more receptive to novel or unusual ideas, and this stimulates the individual to more freely express themself.

IGP Brainstorming Technique

This previous research suggests that perhaps Osborn's traditional group brainstorming process itself needs to be altered, in order to take advantage of both the individual process and group process of idea production. Most of the research indicates that the most productive generation of ideas occurs when individuals brainstorm by themselves and then combine their ideas in a "nominal group". I am proposing an alternative method of brainstorming called the IGP (Individualized-Grouped-Personalized), which will allow the participants to experience the benefits of both individual and grouped sessions. It is similar in every way to Osborn's original brainstorming rules, except that it allows for an individual session both before and after the group brainstorming activity. The overall design of the IGP begins with an individual session, followed by a group session, and ending with a follow up individual session. This allows for more emphasis on the individual sessions which have proven to be more productive, but also uses the group activity to stimulate further individual processing.

It is hoped that the individual sessions preceding the group session will allow for cognitive rehearsal and orientation that may alleviate the effect of production blocking. This will also allow the group brainstorming session to incorporate the Nominal Group Technique developed by Van de Ven and Delbecq (1975) which suggests that allowing individuals to write down their ideas before a group session facilitates: "self-disclosure of ideas, even by less secure members who may hesitate to bring some problem dimension before the group in the conventional interacting situation."

The IGP should also benefit from the "warm-up" of having a group session before the final individual session. This will serve to stimulate individual productivity as a function of the dynamics of group interactions and the cognitive arousal caused by exposure to new and challenging ideas. The final individual session should benefit from the arousal and increased intrinsic motivation caused by the previous group participation. However, it will also allow individuals to be free from the distraction-conflict that is often caused by group interactions and which results in cognitive overload.

It should also be noted that the IGP is constructed to allow for individual differences; the personality characteristics that are indicated by personal communication apprehension scores. The group session should be conducive to "Low Apprehensives" who generally produce more ideas when in a condition of interpersonal interactions. While the overall emphasis on individual sessions will be less intimidating and more productive for "High Apprehensive" individuals, who frequently find the group process less comfortable and productive. Overall, the IGP attempts to incorporate the way individuals learn by social interaction, as well as the way learning occurs through the process of personal cognition.

The purpose of this experiment is to determine if an alternative method of brainstorming, the IGP, will enable learning groups to increase the total amount of ideas they produce. By integrating the proven benefits of an individualized (nominal) condition with the suspected cognitive benefits of group interactions, the IGP should provide a more productive brainstorming condition than does the traditional group brainstorming method. The IGP is an attempt to synthesize the process of social learning with the process of individual creativity. This not only takes into account learner preferences, as evidenced by their communication apprehension traits, but also provides individual sessions to alleviate the apparent variety of "effects" associated with group participation.

The PRCA test has seldom been used with younger learners, but it should provide valuable information in regards to individual learning styles that deserve consideration. I am blocking for levels of communication apprehension to control for their documented differences in regards to group brainstorming ideation. I also want to examine if the two different types of brainstorming treatment evidence any differential effect in regards to individual levels of communication apprehension. It is suspected that the IGP treatment should enhance the productivity of High Apprehensives because of the IGP's emphasis on individual sessions. However, the IGP should also improve overall group productivity by synthesizing the creative experiences of both group processing and the individual process of reflection or personal cognition.

Methods

Subjects

Participants were 108 seventh graders (49 female/59 male) from an urban Midwestern public middle school. All were enrolled in mixed ability English composition classes, where group brainstorming is introduced as a technique for the creative generation of ideas.

Materials

A workshop was created to provide a training session on the activity of brainstorming, as well as present practice exercises using both the brainstorming treatments. The "Traditional Rules of Brainstorming" were based on Osborn's four main concepts:

1. Do not criticize any ideas
2. All types of ideas are encouraged - the wilder the better
3. The goal is to create as many ideas as possible
4. "Hitch-hiking": using a combination of someone else's ideas to create new ones is encouraged. The facilitator will write down all the group ideas.

The "Rules of the IGP Brainstorming" were based on the above four concepts and included the following procedures:

1. You will first brainstorm individually for 5 minutes. During this session there will be no talking and you need to write down all the ideas that you think of. Keep your "idea sheet".
2. At the end of 5 minutes the facilitator will come around and bring you together in your group. At this time draw a line across the page below your last individual idea.
3. You will be in the group for 10 minutes and at this time you are encouraged to talk with other group members, share your ideas, and create new ideas with the group. The facilitator will write down all the group ideas.
4. At the end of the group session you will return to your seats and individually brainstorm. Use any group ideas to help create new ones (hitch-hike). Write down all the ideas that come to you, including any "repeats" on your "idea sheet". At the end of 5 minutes the facilitator will collect your idea sheet .

The PRCA pre-test is a valid and reliable(.93) measure of communication apprehension (McCroskey, 1970,1985) and an indicator of individual productivity in brainstorming groups (Jablin et. al., 1977). The problems used in this research have also been validated as appropriate brainstorming exercises (Thornburg, 1991; and Renzulli, Owens, and Callahan, 1974).

Design and Procedures

One week before the study, all students were given a workshop devoted to the purposes, instructions and procedures of the two brainstorming treatments. Next all participants were administered the PRCA to assess their individual levels of communication apprehension. The PRCA scores were used to divide students into high or low apprehensives based on their scores in relationship to the test median (60). Participants with scores at or above this median were categorized as "High Communication Apprehensives". Members from these two apprehension categories were then randomly assigned to homogenous groups of four, and these groups were randomly assigned to either a Traditional (Osborn's groups) or IGP brainstorming treatment in a 2x2 factorial design.

During the individual brainstorming sessions of the IGP, subjects wrote down all their ideas; during all group sessions the subjects orally shared their ideas and those were recorded by multiple raters. The subjects were asked to generate as many ideas as possible in 20 minutes on two exercises which have been previously validated as adequate for full ideation (Bouchard, 1969 and Diehl and Stroebe, 1991). The final group scores are based on "fluency" - the total number of unreplicated ideas that each group generated within the 20 minute period.

Results

The results were subjected to an analysis of variance for uneven cell size with a one-way ANOVA. Blocking was done for levels of communication apprehension from the results of the PRCA pre-test (49 HA and 59 LA). Of the 49 HA individuals the majority were found to be female(30/49). The ANOVA produced no significant differences for Treatment F(1, 22)=2.38, $p<.089$; Communication Grouping F(1, 22)=1.50, $p<.236$; Interaction F(1, 22)=0.855, $p<.367$.

Discussion

While there were no statistically significant results the study did provide some interesting findings that will be useful for future studies. Although placing participants in groups of four dominates the existing body of research, there is no evidence that this is a necessary condition, except that it concurs with the precedent set by Taylor et. al. (1957). Using groups of four students greatly diminished the overall power of this study and subsequent research has indicated that smaller group sizes may prove to be equally valid (Thornburg, 1991; Renzulli et. al. 1974). This may have particularly influenced the significance of the IGP treatment effect because the means for the two brainstorming exercises all appear to indicate a difference regardless of the communication level: Question 1 - IGP/81.6 vs. Traditional/62.6; Question 2 - IGP/84.4 vs. Traditional/ 69.0. Surprisingly, no difference was found between the two communication levels, however the LAs did consistently outperform the HAs and the lack of statistical power may have also influenced this outcome. There was an indication of a slight trend, where the difference between the means of HAs and LAs diminished from the first and second exercise (Q1 - HA/61.7 vs. LA/84.6 and Q2 - HA/72.3 vs. LA/81.9). This might suggest that HA's become more socially comfortable over time which positively effects their performance.

Another factor which may have diminished the effect of the IGP was the length of time given for the treatment. In its original design, the IGP would allow more time between the three sessions. The first individual session would occur a few days before the group session, providing an opportunity for the individual generation of ideas as well as an advanced organizer. After the group brainstorming session, participants would be given a copy of all the ideas generated up to that point and then allowed a few days for further ideation. It is believed that the twenty minute sessions provided in this research study is an "artificial" constraint on the cognitive processes of orientation and reflection. However, the longer treatment would be problematic in a school class setting and little control on providing equal "time on task" between the two treatments. Future research might be conducted using the "ideal" IGP treatment condition and allowing for three separate group sessions, even though this might mean sacrificing experimental control of the time variable.

The results of the PRCA pre-test suggests that gender would be an interesting factor to investigate both in regards to communication apprehension and brainstorming performance. The age and nature of this population sample may also have adversely effected the research results. Previous brainstorming studies have usually been performed with an older population, who are more familiar with brainstorming and group work. Future studies may also benefit from more contextually relevant brainstorming exercises concerning personally meaningful problems and a vested interest in the successful discovery of potential and alternative solutions.

Although it was a purposeful intention of this study to examine brainstorming in a "natural" social setting, and thus avoid the confounding effects of an electronically mediated experience, another area for future investigation is the effect of various computer based technologies (Networks and GDSS). Many studies have indicated the effectiveness of a GDSS-type interface and perhaps merging these technologies with a strategy such as the IGP will further enhance idea production. Some advantages of a computer interface would be their capability to overcome various forms of group inhibitions: an anonymous individual condition to negate the effects of evaluation apprehension; an efficient management of the group process through the synchronous expression of ideas (production blocking); an efficient record keeping mechanism of individual contributions. However, since many schools, organizations and groups do not have access to this type of equipment it still remains pertinent to observe the effects of the IGP without an electronic system.

As an area of research, group brainstorming is an interesting example of a popularly employed group activity which is widely believed to increase productivity, yet these actual performance gains are unsubstantiated by existing research. Group brainstorming is a classic paradox concerning the appropriate use of group vs. individual efforts, and thus it reveals many questions as to "what" factors have a negative effect on group performance. Is it the inherent "nature of the task" itself, and what are the specifics of the task demands that perhaps makes a particular activity more appropriate and productive for individual endeavors as opposed to group work? Is it the various effects of group composition and individual differences on group performance? Are the negative influences of "group effects" an inevitable consequence of group work and what group management strategies can be developed to overcome these problems?

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Title:

What We Talk About When We Talk About Philosophy And Educational Research*

*(with apologies to Raymond Carver)

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We do philosophy (theorize) when, for whatever reason, we are aroused to wonder about how events and experiences are interpreted and should be interpreted. We philosophize when we can no longer tolerate the splits and fragmentations in our pictures of the world, when we desire some kind of wholeness and integration, some coherence which is our own (Greene, 1974, pp.10-11). This is private work. This happens on a personal level as we work through the dailiness of everyday life. It becomes public when we struggle with the realities of classroom life.

As educators, we are concerned with philosophical issues and questions in our daily work within classrooms. As we debate curricular issues, as we decide educational policy, as we work with students and their "behavior", as we "test" students' "knowledge", etc., we are concerned with philosophy. However, the underlying ideas behind our practice may go un-noticed, may be unconscious, may be unquestioned. The importance of philosophical inquiry in education is exactly at this point: philosophical inquiry can illuminate, inform, call into question, etc., the taken for granted notions that we have. Philosophical inquiry and analysis can help conceptual clarification, as well as inform our praxis, and vice versa.

In this paper/presentation, I will take the position that philosophy is a critical way to studying schooling. Hence, the study of philosophy/philosophy of education will provide a framework needed for inquiry into schooling that is foundational (theoretical), diverse, and critical. This will suggest the need for taking a theoretical stance with regard to our work.[1]

Taking a theoretical stance with regard to our work suggests dealing with a broad analysis of education, i.e., concern with "the big picture". The big picture of education is complicated. At the same time, educators are confronted with a sense of urgency to solve educational problems. Philosophy is too time consuming. As Eisner (1991) states, "Philosophy is nagging. It conjoles students into asking questions about basic assumptions, it generates doubts and uncertainties, and, it is said, it keeps people from getting their work done" (pp.4-5). Philosophizing about the issues does take time, and it is messy. And this does seem to take us away from our work.

PHILOSOPHICAL FRAMEWORKS FOR INQUIRY

Philosophical inquiry provides ways for educators to "inquire into their work", to question their theory and practice. Processes of philosophical inquiry include the following: (1) conceptual analysis; (2) situating educational issues within philosophical traditions; (3) the examination of epistemological and axiological assumptions, criticisms, and (4) critical thinking and analysis of existing literature and theory. These processes are ways of doing philosophy.[2]

I believe philosophy is the foundation (theory) of educational research. This can be seen by posing the basic questions of philosophy: What is the nature of reality? What is the nature of knowledge? What is of value? These questions provide a conceptual framework that gives coherence to the study of philosophy. These questions also identify the major concerns of education and provide the possibility for a coherence in educational practice. By coherence I mean they provide educators with a possible framework for posing questions from multiple perspectives that allow us to reflect on our work. For example, they allow us to pose multiple questions regarding the nature of curricula. They allow us to examine whose knowledge we are promoting, and even prior to that, what knowledge is of most worth. Questions of value ask us why we choose this particular knowledge, and leave all of the rest out, etc. Engaging in this questioning is philosophical inquiry, is doing philosophy.

Another framework I can use in looking at the relationship between philosophy, research and education, would be an examination of the differing approaches to the study of philosophy. Wingo (1974) states that we can approach the study of philosophy in three different ways (these ways may also be looked at as the main functions of philosophy): the descriptive, the normative, and the analytic (pp.15-16).

To engage in descriptive philosophical inquiry, a student would be involved in the study of the history of philosophy. S/he would be studying "what is (and has been) the field of philosophy. Working comprehensively, he is trying to picture the general development of philosophical thought" (p.15). This is more than studying "intellectual history". As Wingo points out, it is possible to study about what philosophers have said, and at the same time be doing philosophy in that we are "analyzing and clarifying concepts and the language in which ideas are expressed" (p.15). This is the area identified earlier as situating educational issues within a philosophical tradition. For example, educational issues looked at from the viewpoint of different philosophies, and what writers within those philosophical traditions said about the issues, how they would go about making sense of those issues, establish a world-view (metaphysics/ontology), a way of knowing (epistemology), and a way to make decisions regarding action (axiology). Philosophy of education textbooks would be good examples of the descriptive perspective (cf. Wingo, 1974; Gutek, 1988; Ozmon and Craver, 1995).

To engage in normative philosophical inquiry a student would be involved with values (axiology). Interests could focus on ethics or aesthetics. He will be involved with advocating some ends or objectives (values) that he believes to be desirable and with explaining the reasons for their desirability. He may also be involved in suggesting means for advocating these values. His main concern is not what is, but what ought to be. (p.15) Normative philosophical inquiry explores and critiques philosophical positions, as well as makes decisions as the "rightness and wrongness" of those positions (see Webb, et al, 1992). The normative perspective requires an examination of epistemological and axiological assumptions, as well as critical thinking and analysis of existing literature and theory as part of inquiry (cf. Kaufmann, 1974; Dewey, 1904 [1964]).

To engage in analytic philosophical inquiry is to engage in the "analysis of language, concepts, theories, and so on" (Wingo, 1974, p.15). This is the practice that analytic philosophers consider "doing philosophy". According to Webb, et al. (1992), analytic philosophy has as its goal to improve our understanding of education by clarifying our educational concepts, beliefs, arguments, assumptions. For example, an analytic philosophy of education would attempt to understand such questions as: What is experience? What is understanding? What is readiness? (pp.174-5) The analytic perspective has to do with conceptual analysis (cf., Tom, 1984; Wilson, 1963).

This framework of the "functions" of philosophy suggests the foundations position mentioned earlier. Each of these three functions can provide multiple possibilities for educational research and, more specifically, philosophical inquiry. The descriptive, normative and analytic forms of philosophical inquiry suggest indepth study of the philosophy of education. Looking at different philosophical traditions with regards to metaphysics/ontology, epistemology and axiology requires study in philosophy. Movements in education, e.g., reconstructionism, perrenialism, essentialism, Marxism and education, and more recent movements rooted in critical theory, postmodern analyses, renewed emphasis on democratic schooling and forms of emancipatory praxis, etc., represent major areas of study for researchers. These areas of study have their own world-views and concerns. Writers within these positions offer differing conceptual frameworks, differing questions posed, and hence challenges to status quo practice. And they all engage the student in philosophical inquiry.

The study of the philosophy of education from the normative, descriptive and analytic perspectives offer critical means of inquiry into educational realities for researchers. Writing within these frameworks is doing philosophy. Doing philosophy is doing research. The descriptive perspective works out of systems of philosophical thought, schools of thought, offering foundational positions from which to work; the normative perspective offers a "process of inquiry into ideas and basic beliefs that will enable us to form reasoned attitudes about the important issues of our time" (Wingo, 1974, p.22). The analytic perspective allows us to inquire into the use of language, the meaning, and clarification of language used to talk about education. This is philosophical inquiry. This is doing philosophy.

Those of us involved in education know that it is a very complex social undertaking. It has many important dimensions that can be examined from psychological, sociological, political perspectives, yet there is one question that is uniquely philosophical: "the question of determining the ends of education" (Wingo, 1974, p.22). The means and ends of education are inseparably united. Wingo (1974) quotes Max Black:

All serious discussion of educational problems, no matter how specific, soon leads to consideration of educational aims, and becomes a conversation about the good life, the nature of man, the varieties of experience. But these are the perennial themes of philosophical investigation.

It might be a hard thing to expect educators to be philosophical, but can they be anything else? (p.22)
Conceptualizations about "the good life", the nature of humankind, etc., are problematic because there are no final, all inclusive positions on these concepts. Inquiry into these issues can take place through the descriptive, normative, and analytic perspectives. And each of these perspectives will demand different questions be posed. This process is doing philosophy, doing philosophical inquiry.

To understand how the three perspectives can be used in the study of education, Wingo (1974) suggests that there are three assumptions that underlie the nature of philosophical inquiry in education. These three assumptions are critical to an understanding of the importance, scope, and possibility the study of philosophy has for the study of education. As obvious as it may seem, the first assumption is: "The primary subject matter of philosophy of education is education itself" (p.24). Thus the phenomena of education, in all its myriad forms, are the "subject matter" for study. From a research point of view this can mean looking at curricula, the outcomes of learning, testing, organizational matters, place of schools within the social setting, the means-ends of education, etc., etc.

The second, and perhaps the most insightful and critical assumption, states that "Education always takes place within a certain constellation of cultural conditions and therefore it cannot be studied as a set of universal and independent phenomena" (p.24). This assumption means that there is no "one best system" to model schools after and no single answer to complex educational situations. This assumption suggests that we need to view education relationally, in context (cf Apple, 1979; Beyer, 1986; Purpel, 1993), and clearly identifies the complex nature of understanding education. At the same time this assumption suggests the myriad possibilities for inquiry into the process of schooling. By this I mean that the nature of the inquiry is dependent upon the researcher. It is not standardized, it is not given (cf. Eisner, 1991).

The third assumption underlying the nature of philosophical inquiry in education states that the "basic purpose of philosophy of education applies to the ends and means of education and their interrelationships" (Wingo, 1974, p.24). The assumption suggests the complexity of educational experience and the many variables/ factors that influence the process. These assumptions clearly call for the descriptive, normative, and analytic perspectives of viewing educational realities, but also point toward the need for expanding our decision to accomodate other perspectives such as interpretive and critical forms of inquiry, as well as the empirical.

A way to expand my discussion to accomodate other perspectives that can be used in looking at the relationship between philosophy, inquiry and education can be found in examining research paradigms. This framework (research paradigms) extends the more traditional descriptive, normative and analytic perspectives by looking at methodological/ epistemological viewpoints. This framework allows the researcher to identify human interests within modes of inquiry.

Bredo and Feinberg (1982) discuss differing paradigms according to the research methodologies utilized. These methodologies have inherent interests in the kind of research findings sought and generated. The paradigms identified are the empirical, or positivistic, the interpretive, and the critical approaches to social and educational research. These paradigms have fundamental differences that separate the positivistic from the interpretive and critical approaches. These differences are of a philosophical nature concerning the nature of reality (metaphysics), subject-object dualism, generalization, causality, and axiology (Koetting, 1985; 1993), and how we come to know reality in any way whatsoever (epistemology). These concerns keep us rooted in doing philosophy.

FOUNDATIONS AND THEORY

Although I have used the term "foundations" frequently in this section, I am not talking about the establishment of a "meta-narrative" (Lyotard, 1984; Hlynka and Yeaman, 1992). I am not talking about "doing philosophy in the grand manner" of building systems of thought (Wingo, 1974). I do not believe that there is only one complete explanation or understanding of our social world and that given the time and effort we will be able to "figure things out". What I am saying about foundations is the way in which philosophy is carried out, within philosophical inquiry, the problem-posing, the questioning, the search for clarification, the quest for seeing things relationally, provides multiple ways of inquiring into the world of social and educational realities.

Martusewicz and Reynolds (1994) state a similar position regarding foundations. They see the purpose of foundations to raise questions and offer points of view that ask us to see what we do as teachers or as students in new or at least unfamiliar ways, from another side, perhaps from the inside, of perhaps from both inside and outside. It is an invitation to look at education both socially and historically as well as practically, that is, from the inside (the complex processes, methods, and relations that affect individuals in schools, for example) within the context of the outside (the larger social, economic, and political forces that have affected those processes over time). (p.2)

This notion of inside/outside (school/world) provides a sociocultural perspective that suggests the "flux of boundaries", and allows the researcher/participant to see the relationships of seemingly separate realities, as well as questions the idea of foundations as a "stable set of knowledges, concepts, or principles to be discovered, defined, and then presented in a unilinear way" (Martusewicz and Reynolds, 1994, p.3; also see Greene, 1974). Again, there is no one best way to explain what happens in the world or in education. Possibilities for understanding, however, can take place when we pay "particular attention to perspectives that maintain a critical stance, a willingness to put existing assumptions and interpretations into question" (Martusewicz and Reynolds, 1994, p.3).

As I become engaged in this form of critical inquiry, I become involved in theory (foundations). There are multiple theoretical perspectives on the world, knowledge, value. However, there is no meta-narrative. There is no grand philosophy (Greene, 1974; 1994; and Martusewicz & Reynolds, 1994). Returning to an assumption made earlier from Wingo (1974),

Education always takes place within a certain constellation of cultural conditions and therefore it cannot be studied as a set of universal and independent phenomena. Some set of relations among education, politics, and social institutions is inevitable and cannot be ignored in any useful analysis (p.24). There are multiple explanations/understandings of schooling, of the "world", and multiple ways of knowing. Multiple ways of understanding the world of education have to do with theory. Understanding the notion of theory can provide insight into the multiple interpretations of the world and experience. Theorizing is a mode of philosophical inquiry that suggests the complexities and possibilities for creating/constructing knowledge. And that is the subject of another series of papers.[3]

ENDNOTES

1. Part of this paper comes from my extended essay "Philosophy, education and research", which appears in David H. Jonassen (In press). Handbook of research on educational communications and technology. NY: Scholastic.

2. See Anderson (1990) for a discussion of educational research and the place of philosophy within educational research.

3. See Hlynka and Belland, 1991; Koetting and Januszewski, 1991; Yeaman, Andersen, Damarin, and Muffoletto, in press; and Nichols and Allen-Brown, in press.

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Title:

A Hypermedia System to Aid in Preservice Teacher Education: Instructional Design and Evaluation

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This research investigated how use of an interactive videodisk information system helped preservice teachers (PSTs) expand their visions of teaching, learning, and assessment in mathematics and their skills in translating that vision into action in the classroom. The technology was used as one element in the field experience component of a masters certification program for prospective elementary teachers and provided them with models of effective teaching around which class discussions and individual journal reflections were based. The data we collected document how students used the technology in formulating personal visions of effective teaching, how they planned and taught lessons to actual classes of children, how they critiqued their own teaching and the teaching of others, and how their philosophies and beliefs about teaching and learning developed throughout the course.

Rationale

Changes are in the air in schools in the United States: changes in curricula, changes in teaching methods, and changes in assessment. As a result, teacher education must change as well. In March 1989, the National Council of Teachers of Mathematics (NCTM) released its Curriculum and Evaluation Standards for School Mathematics. Central to the message of the Curriculum and Evaluation Standards is the development of mathematical power for all students, described as the ability "to explore, conjecture, and reason logically as well as the ability to use a variety of mathematical methods effectively to solve nonroutine problems. This notion is based on the recognition of mathematics as more than a collection of concepts and skills to be mastered; it includes methods of investigating and reasoning, means of communication, and notions of context" (NCTM, 1989, p. 5).

Research findings from cognitive psychology and mathematics education indicate that students learn as they actively assimilate new information and experiences to construct their own meanings (Case & Bereiter, 1984; Cobb & Steffe 1983; David, 1984; Hiebert, 1986; Lampert, 1986, 1990; Schoenfeld, 1987). Since this is—of course—just as true of the learning of prospective teachers as of any students, we as teacher educators must practice what we teach. That is, we cannot hope to produce teachers who can adapt to new notions of what it means to teach mathematics unless we change our own teaching practices as well.

Recognizing that reaching the goal of developing mathematical power for all students requires teachers with new and different philosophies and competencies, the NCTM published—in 1991—a companion set of standards: the Professional Teaching Standards for School Mathematics. This document identifies the need for mathematics teachers who are proficient—among other things— in "selecting mathematical tasks to engage students' interests and intellect; providing opportunities to deepen students' understanding of the mathematics being studied and its applications; orchestrating classroom discourse in ways that promote the investigation and growth of mathematical ideas; using, and helping students use, technology and other tools to pursue mathematical investigations; seeking, and helping students seek, connections to previous and developing knowledge; [and] guiding individual, small-group, and whole-class work" (NCTM, 1991, p. 1).

The goal of this research study was to investigate how use of an interactive videodisk information system (the Strategic Teaching Framework) in a field experience course for preservice teachers (PSTs) might help them expand their visions of teaching, learning, and assessment in mathematics and their skills in translating that vision into action in the classroom.

The Strategic Teaching Framework

Strategic Teaching Framework[9] (STF) is an interactive videodisk information system designed to help individuals develop teaching strategies that are problem-solving oriented, that focus on both students and processes, and that utilize collaborative work as a means for testing ideas. The system is written in Hypercard and runs on a Macintosh computer. Videos of classrooms are stored on videodisk with presentation of the video and supporting materials controlled through the STF interface.

STF was designed to support teachers through a constructivist or process-oriented learning environment (Duffy, in press)—in particular, the sort of environment reflected in models of cognitive apprenticeship (Brown, Collins, & Duguid, 1989) and of the reflective practitioner (Schon, 1989). The STF module consists of video of a full class period of teaching by three elementary school teachers[10], each of whom exhibits characteristics consistent with the recommendations of the Professional Teaching Standards (NCTM, 1991). One of the STF design strategies was to provide access to multiple, sometimes very different, representations of exemplary (learner-centered, collaborative, problem driven) practice to aid prospective teachers in understanding that the teaching strategies illustrated should not be seen as practices to be slavishly imitated but, rather, as providing the underpinnings for a conceptual framework to guide practice.

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[9] Strategic Teaching Framework was a joint project of Indiana University and the North Central Regional Education Laboratory. Lead designers for the program were Thomas Duffy, Beau Jones, and Randy Knuth.

The videos of the three teachers each teaching a full class period of instruction is the heart of the STF system. STF very consciously does not focus on isolated skills or on idealized demonstrations, but instead emphasizes the interrelatedness of teaching practices by presenting them in context. The design strategy was to avoid teaching the critical attributes in the video for two reasons. First, the critical points or attributes in an actual teaching experience are really a matter of one's perspective rather than a reality. Second, within the constructivist and apprenticeship mode, the goal was to aid the learner in developing and evaluating his or her own perspective on critical issues. It was believed that learning would be more effective if it was learner (teacher) centered rather than system specified. The perspectives provided on the teaching in the videos further reflected this design strategy of supporting the teacher-learner's constructive activity and providing a basis for testing those constructions. Rather than a single perspective on the important aspects of the teaching, STF provides commentary from three different perspectives: the featured teacher, a mathematics educator, and the STF developers. The perspectives are "attached" to the video, so that the learner can obtain the three perspectives on the particular teaching activity currently being viewed.

A second part of the STF information system is a conceptually organized information base. Topics include assessment, management, teaching strategies, problem solving, and planning. For each of these topics there are 4 to 12 subtopics, and for each subtopic the learner can get several types of information: perspectives on the video and the videoclip that are directly related to that subtopic; references to a specific reference article in a hardcopy library that is part of STF; or an interview with the teacher or with one of three education experts. Thus, after studying the classroom as a whole, the learner can move to the information base to develop a richer understanding of various aspects of the teaching. Additionally, a notetaking feature is built in to the system to allow users to attach their own comments to or establish a dialogue around a video segment.

The Research Agenda

The focus of this research project was the design and formative evaluation of an instructional model to support the use of STF in mathematics teacher education. Because this was a first evaluation of the STF system in a teaching context, it was important to document in considerable detail how the students worked with the STF system and how they implemented—in their field experience classrooms—the strategies illustrated by STF. We also were interested in describing the extent to which the PSTs exhibited reflective, situated decision making during teaching. Data on use of STF came from observations, student journals, and computer logs of the frequency and types of use. (These data will also serve later to guide revision of the system.)

Our instructional model emphasized PSTs' construction and testing (through collaboration, observation, and practice) of their own conceptual frameworks for what it means to teach mathematics according to the recommendations of the NCTM standards documents. It also encouraged the prospective teachers to reflect both on teaching practices and on students' learning—a promising strategy for changing the way mathematics is taught, learned, and assessed (Tobin, 1989). When PSTs actively participate in evaluating classroom lessons, they can begin to create new, more effective frameworks for helping the students they teach make mathematical connections.

Our instructional model contained elements of both the cognitive apprentice and the reflective practitioner models of teacher education (Duffy, in press). Central to both of these models is the notion that learning must be purposeful—that there should be a realistic task or goal for which the learning will be used. This notion provides learners with a framework for developing self regulation in identifying learning goals, carrying out designated tasks, and self-assessing progress in learning through accomplishing the task. In our model, the task was for each PST to develop and deliver mathematics instruction to the class of elementary students to which he or she had been assigned for a semester-long early field experience in mathematics and science teaching.

Consistent with the cognitive apprenticeship model, STF provides—through its video exemplars, its clips of expert commentary, and its library of resources—expert models and multiple perspectives on their performance. Further, collaboration among peers, as well as interactions with the university supervisor, the cooperating teachers, and the elementary students in the classroom provided a vehicle for the PSTs to develop and test their own conceptual frameworks for instruction. Consistent with the reflective practitioner model, our use of STF emphasized a cycle of reflection-in-action. This reflection-in-action began with the PSTs reflecting on the action of two teachers in the STF video, moved next to reflections on the teaching of the cooperating teacher in the field experience classroom, and progressed to reflection on the PST's own performance in the classroom.

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[10] These exemplary teachers are Vickie Bill, St. Agnes Elementary School, Pittsburgh; David Birchfield, Brownsville Elementary School, Charlottesville VA; and Dwight Cooley, Alice Carlson Applied Learning Center, Ft. Worth TX. At the time of this study, Dwight Cooley had not yet been added to the STF system. His class was only available on videotape.

This paper focuses specifically on the use and impact of STF in a course for PSTs, though the work reported here represents just a portion of a larger study designed to examine the PST's growth in thought and action and development as reflective practioners.

Method

Subjects

The subjects in the study were 16 preservice teachers enrolled in Indiana University's Elementary Certification Graduate Program (ECGP). Students in the class of sixteen ranged from 23 - 45 years of age,. Only one student (Pete[11]) was already a certified teacher (of secondary social studies), but several students had experience as substitute teachers, tutors, or classroom volunteers. Roughly half the class was married, and many had children at home. All students were changing current careers to become elementary teachers. The class was composed of ten women and six men.

All of these students contributed to the data on the use of STF. Eight of them, four men and four women, were selected for a more intensive analysis of their journals and other reflective contributions regarding their beliefs, attitudes and strategies for using STF and its contribution to their growth as a perspective teacher. These students were selected at the end of data collection, but prior to any analysis, based on two criteria. First, they had written extensive journals. Second, in the teacher's estimation and based on class assessment instruments, these eight students seemed to represent a cross section of the class in terms of range of their understanding of learner centered instruction, their classroom experiences, and their growth over the course of the semester.

The Teacher Education Program

The ECGP program is designed for students who already have liberal arts, humanities, or social or natural science baccalaureate degrees, but have returned to the university to work concurrently on certification as elementary teachers and a masters degree. The program seemed a particularly appropriate site for experimenting with use of STF in a teacher education setting because the ECGP program was explicitly founded upon the following principle: "Teacher education is viewed primarily as a process of praxis. Students are assisted to construct their own personal theories of education (based upon personal experiences and course experiences), are given opportunities to test these theories in a variety of field experiences, and are continually encouraged to reflect upon all three types of experiences (personal, course, and field) in revising and reconceptualizing their theories" (ECGP Program Description, 1993, p. 3).

The Curriculum and Course

The students were concurrently enrolled in E543 (Advanced Study in the Teaching of Mathematics in the Elementary School) and M501 (Laboratory/Field Experience.), both taught by the first author. Use of STF was a new, but integral, part of the ECGP M501 field experience.

M501 is an early field experience course scheduled to meet one full day per week for a semester. As part of the, course, each prospective teacher is assigned to an elementary school classroom and spends one day per week for about 12 weeks at the school with that teacher and his or her class. The PSTs enrolled in M501 are given four mathematics assignments to be carried out in the school: (1) to conduct a series of interviews with three children— at diverse levels of ability — in an elementary school classroom, and (2) - (4) to design and present three mathematics lessons to the class as a whole.

Before developing their interview questions, the PSTs view a videotape on effective, interviewing techniques for mathematics assessment (Burns, 1993). They then conduct their interviews with children, audio-recording one of them for later review, transcription, and analysis in a paper written for the course. The interview assignment serves two purposes: to provide the PSTs with a detailed look at how children of a particular age think about mathematical concepts and solve problems, and to encourage them to reflect on their own ideas about children's understandings and their own questioning techniques.

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[11] Names used are psueudonyms for students in the study.

In each of the three lessons that the PSTs design and teach (two of which are eventually self-critiqued in course papers), they are instructed to incorporate at least one of the following: collaborative learning, the use of manipulatives, teaching a mathematical concept via problem solving, and deriving mathematical problems from narratives (i.e., literature-based mathematics teaching). These aspects of mathematics instruction are supported by recommendations of the NCTM Standards and are also illustrated in the STF module.

Incorporating the use of STF into the M501 curriculum required a reallocation of time during the course. For weeks two to five of the term, students spent half of their M501 course time (that is, one afternoon per week) at the university working with STF and on the design of lesson plans. During these same weeks, the other half of their M501 course time, (that is, one morning per week) was spent either in teaching workshops (during weeks two and three) or in work in their field experience classroom at the school (during weeks four and five). From the 6th to the 13th week of the term, the PSTs spent an entire day each week in their field experience classrooms, but had a one-hour meeting per week at the university for discussion and debriefing (as well as three hours per week in Mathematics Methods class — where considerable discussion about teaching took place as well). The PSTs' teaching of mathematics lessons in the schools was done during weeks 6-9 of the semester.

The resources available to the prospective teachers as they planned their lessons included:

- The classroom to which they were assigned (as a source of information on the culture of the classroom and the skills/knowledge/problem solving strategies of the children).
- The mathematics methods class (as a source of information on appropriate content and sequencing for math instruction).
- STF (as a source of information on mathematics teaching strategies and goals).

STF Facilities

Four Apple IIci workstations were available for the class. The peripherals associated with each computer included a CD-ROM player, video disk player, and monitor. Copies of the STF software and videodisks were kept with each workstation. Students were also able to check out videotapes and hardcopies of the CD-ROM information for home use.

The computers were in laboratory settings which included a large table and space for the team to gather and work. Other students in one of the School's programs had access to these computers for their work, but the PSTs had priority and were able, to access the machines any time they desired. The shared access, however, did mean that some reconfiguring was often necessary before the students could work. The two most frequent issues were disconnecting the machines from the network and reattaching the CD ROM player as a peripheral.

Strategy for Using STF

There were STF based classroom assignments each Monday afternoon for weeks 2-5 of the class (the first week was spent orienting students to the course). For this paper, these weeks will be referred to as STF week 1 (or session 1), STF week 2 (session 2), etc.. Additionally the students had access to STF at any time throughout the semester. The students worked with STF in teams of four to five, with each team assigned to one of the four computers.

In the first STF session, the M501 class examined the teaching of one of the three teachers in the STF system (Vickie Bill). Each group viewed the video of Vickie Bill's lesson with the goal of identifying the key features of her approach to teaching and analyzing how and why these components of the teaching are important. These analyses were then shared in the final hour of the class, in whole-class discussions and further elaborated upon in individual journal assignments. As part of their reflective journals (which were turned in weekly for commentary by the first and third authors), PSTs recorded their thoughts on the implications of their analysis of the STF teachers for their own images of effective mathematics teaching and for their own soon-to-be written mathematics lesson plans.

In STF week 2, the students discussed further their reaction to Vickie Bill, then were sent in their groups to watch and analyze second teacher in the STF system, David Birchfield. As with Vicki, they were asked to identify the key features of David's teaching and analyze how and why these components were important. During the week, students were asked to continue to analyze the teaching of David Birchfield, focusing on questioning strategies. Discussion, analysis, and reflection via journal ensued similar to that of week 1, with additional emphasis on analyzing both David and Vickie's questioning strategies.

In STF week 3, students were sent in their groups to the STF stations immediately, to identify and prepare to bring back to the class examples of Vickie and David which exemplified what they believed to be key elements to teaching (which required the group to come to consensus on those elements first). Students spent the last half of the class presenting their STF examples and engaging in discussion about them. Journal entries for this week focused on their questions, concerns, and insecurities about their field experience (they had visited their classrooms for the first time that morning). They were asked to use STF to explore and comment on these issues.

The fourth week of STF work involved students in actually conceptualizing and writing a plan for a mathematics lesson. This planning was done in small groups, shared and critiqued in whole class discussion, and then became the topic of a reflective writing assignment for individuals' journals.

Field Experience

The PSTs were each assigned to an elementary (grades 1 to 6) classroom and teacher in one of two schools within a twenty minute drive of the University. Once the students were working full-time in the elementary school (beginning in week 5), they proceeded to the tasks of conducting their diagnostic interviews and planning and teaching their three lessons. Each week they wrote extensive commentary in their field experience journals about observations they were making in the classroom, issues that were arising, beliefs that were being challenged, and successes and failures that they were experiencing. The students were encouraged to return, whenever it seemed useful, to STF as a resource.

Between weeks six and nine the students were required to teach three mathematics lessons in the elementary classroom. The first and third authors attended at least one of the teaching sessions of each PST and provided written feedback to the students afterward. They were also videotaped during at least one of the three lessons. Videotaping was done by students in another program in the school. The tape was given to the PST after class with instructions to watch the video, analyze the teaching, reflect on their own performance, and write a thoughtful critique.

Data Sources and Analysis

Data about students' use of and attitudes about the STF system were collected in a number of ways. Keystroke data, student journals, and reflections on videotapes of their own teaching provided the researchers with information about the use and impact of STF throughout the entire semester. Additionally, the teacher of the class (the first author) provided reflections of the use and impact of STF from the instructor's perspective.

Keystroke data. STF software included a program to record login information and the time of all keystrokes while using the program. This data provided us with a record of what STF features were used by whom, when, and for how long.

Student reflective journals The students kept weekly journals in which they reflected on their use of the STF system, their growing understanding of effective teaching, and their reactions to their field experiences and class activities. The first and third authors responded in writing to these journal entries weekly, creating a written conversational trail of students' progress in thinking and researcher reaction to it throughout the course. While students were encouraged to write about any experience or reflection, there were specific questions, topics, or issues identified for journaling each week. These questions were based on a combination of the goals of the week's activity and the nature of the discussion during the class period. The journaling questions posed for each of the four weeks STF was assigned were as follows:

STF week 1:
1) Watch and analyze Vickie Bill on STF. Based on what you see, what are three things you believe contribute to good mathematics teaching?
2) Evaluate STF — what do you think is helpful? Any complaints?

STF week 2:
1) Last week you wrote about three things you believe contribute to good mathematics teaching. Since then you have watched David Birchfield on STF. As a result of that additional experience, what would you like to add to or change in your previous journal entry? Explain why.
2) Discuss and comment on the questioning strategies used by Vickie Bill and David Birchfield. Explain why you think their strategies are effective or ineffective.
3) Identify the two aspects of STF as a technology that have been most useful to you. Explain. Identify the two aspects that have been most confusing or frustrating. Explain. Overall, how useful has STF been in helping you develop notions of good mathematics teaching (on a scale of 1 = not at all helpful to 10=extremely helpful)? Explain.

STF week 3:
What are your questions, concerns, and insecurities about your field experience. How do you plan on approaching these concerns? Use STF to explore and comment on these issues.

STF week 4: 1) Discuss the group lesson planning experience on Sept 26. Was it helpful? Could it be improved?

2) Discuss your field experience and any issues that it is raising for you.

End of course: Students were asked to reflect on their STF experience at the the end of the course in a journal assignment and in the course evaluation.

The journal entries for the entire semester were analyzed for the eight case study students in the class (see "Subjects") using the Constant Comparison Method outlined by Glasser and Strauss (1975). The entries were divided into idea units, defined as a focused comment about some event or experience. The first and third authors worked on successive samples of journals until they established 80% agreement on the division into idea units and they could apply those divisions to another sample with similar agreement. Then the third author divided the remainder of the journals into idea units.

The idea units were sorted by each of the researchers into categories of ideas that seemed to go together. The categories were then named. Several iterations of this process led to a matrix of categories into which comments about experiences were placed. Idea units were categorized on two dimensions: the experience that was being reacted to; and the type of comment about that experience. The experiences being reacted to are the primary instructional components of the course plus prior experience as learners and teachers: STF, the field experience, their teaching experience, the interview assignment, activities in the Math Methods class, other ECGP classes, and experiences outside of the University program.

The comments on each of those experiences were first sorted into two categories: comments that discussed what was learned from the experience; and comments on the design and effectiveness of the experience as part of the course, e.g., how the use of STF could be made a more effective part of the course. This classification scheme is represented in the table below (see Table 1). Some comments were also cross-categorized in terms of how the experience helped them develop new insights on: teaching practices; learning and schooling; specific teaching strategies (e.g., the strategy for questioning); guiding their personal development as a teacher; their current teaching style/beliefs; and mathematics as a discipline.

Table 1

Data Categorization Scheme

	Comentary on/ Learned From	Evaluation of
STF		
Field Experience		
Teaching (including video of them teaching)		
Interviewing children (including video on interviewing skills)		
Instructor's Activities		
Other EGCP Classes		
Non-University Experience		

Once the categorization scheme was in place, the first and third author independently categorized a random selection of 13% of the comments to establish reliability. This process yielded 80% agreement. Considering the substantial number of categories and the placement of comments into multiple categories, we believe 80% agreement is more than acceptable. This complete analysis is supporting a larger research effort. For purposes of the research reported here, our focus is on the nature of the comments about STF.

Teaching videos and reflections on teaching. During the last two weeks of class, volunteer students (twelve in all, including seven of the eight case study students) brought in one of their own videotaped lessons and reflected on their own teaching with the third author. Students were told to be prepared to show and critique examples of questioning, problem solving, and group work. These discussions/interviews were audio taped, transcribed, and unitized in the same manner as the journal comments.

Teacher Reflections Towards the end of the semester, the third author interviewed the instructor (first author) about her expectations of the system, the use of STF in her class, the resulting impact of its use during the semester, and ways in which its use could be modified for future classes. The interview was audiotaped and transcribed.

Results and Discussion

The use of STF

Twenty-nine sessions on the STF system were recorded with an average overall length of 58.37 min. per session. Students used the system outside of the normal class time more often than they used it during class: 13 in class sessions vs. 16 out of class sessions. Generally all four members of the team participated in the sessions. However, the sessions outside of the classroom did vary in group size with at least one of the sessions involving one student working with STF on her own.

All twenty-nine sessions occurred during the four weeks that STF was an assignment in the course. Although the students used STF outside of classtime and were enthusiastic in their assessment of it, they did not use STF from weeks six to thirteen as an explicit tool for preparing the lessons they taught in the school or for reflecting on their teaching afterwards. Most students felt there was only so much they could learn from the two teachers in STF and indicated in their journals that they wished they had more STF teachers to view. Their choice not to return to STF after the first month most likely represents this saturation.

Table 2 summarizes the mean amount of time spent on each of the components of STF and the proportion of the total time that it represented. We were surprised to find that the students distributed their time rather evenly over the three primary information resources: the video (26%), the commentary on the video (21%), and the database of information on the teaching strategies (26%) represented in STF. The use of these three components represented 70% of the time spent on STF.

Table 2
Distribution of time spent on the components of STF

	Activity						
	view video	listen to perspectives	use database	view elaboration	listen to orientation	use notes	Totals
Mean Time	15.35	12.37	15.00	1.80	1.19	4.10	49.81
Proportion of Total Time	26.3%	21.2%	25.7%	3.1%	2.0%	7.0%	85.3%

There were some differences between the STF sessions that occurred during the regular class schedule (classtime STF) and those sessions initiated by the students outside of the scheduled class time (after-class STF). The after-class STF sessions on average were shorter in duration (53.3 and 67.2 minutes respectively). In the classtime STF sessions, the focus tended to be on viewing and discussing the videos, with this activity consuming 47.7% of the session as compared to only 12% of the after-class sessions). In contrast, the after-class sessions tended to focus on the use of the information base with 36.2% of the session spent in the database as compared to 10.4% of classtime sessions. For both classtime and after-class sessions the students spent about a fifth of the session (22.4% and 20.3% respectively) listening to and discussing the expect perspectives with a mean of 5.5 and 6.2 perspectives respectively listened to during a session.

There had been some concern that students would simply view the videos and not engage in any analysis beyond that generated from their observations. Therefore, we were pleased to see that all three of the primary STF information resources — videos, perspectives, and the database -were used about evenly. While the assignment required the students to analyze the videos, that analysis did not specifically require viewing anything beyond the videos themselves. Hence, the extensive use of the database and perspective resources does suggest that the students found this supportive information useful in their analyses.

The Ease of Use

The use of STF was not without technical problems. However, most of the problems occurred with just one of the four stations. There were persistent problems with this station in accessing the audio and, on occasions, it was difficult to start the program. The cause of the problems was never identified. These problems led Gary, one of the students, to say, "Has a day yet gone by when all four STF set-ups were all working properly without any problems? . . . If so, how many days in a row?" The only other equipment difficulties occurred when cables connecting various pieces of the STF system were switched by people using the computers for non-STF work, including connecting the computer to the LAN (which slowed down the responsiveness of the computer), disconnecting the CD-ROM player, and disconnecting the videodisk player. The students generally had to seek help to reconnect the equipment.

While the instructor had initial concerns regarding the ease of use of the system, looking back she stated, "My worry about the students being able to handle the technology probably was unfounded . . . I think some of [the problems] — and it's not the system at all — [were] simply our own physical environment." The instructor did express some concern about using the system without the technical support she received during this project. She doesn't feel confident that she could troubleshoot minor hardware problems that might arise.

STF, itself, was easy for the students to operate. Even novice computer users felt that they adapted to the system quickly. After the first week Matt stated, "I have enjoyed using the STF throughout the past week. Knowing so little about cutting edge computer technology, it was a pleasant surprise to be working with something that is so logical and user friendly." Students had few complaints about the STF interface and few suggestions for improvements. Tina commented that she disliked having to turn the videodisk over as often as she did, and Matt found that the screen saver on his workstation was distracting. Additionally, Pete commented that he wished he had the opportunity to see the entire lesson without a break (the videodisk stops at natural pauses in the classroom, thereby breaking the lesson into many 1-5 minute segments as opposed to one long 40 minute video).

The usefulness of STF

In this section, we report the students' and instructor's sense of the usefulness of STF as a tool for learning. Their comments fell into two broad categories. First, there were comments on the particular components or features of STF. Second, there were comments on the placement and role of STF in the curriculum — its perceived usefulness where it was placed and its relation to other components of the curriculum.

Value of specific STF features. In the initial design of STF, there was some discussion of the value of placing the teaching video on videodisk. We wondered if students could be equally well served by a lower-tech version of the system consisting of videotapes and hard copy printouts of the commentary. How important are the interactive elements of the Hypercard/laserdisk system? The Cognition and Technology Group (1992) has argued for the value of laser disk for rapid access in reviewing and discussing the videos, and our students seem to agree. Starting with the fourth week of the course, we made available videotape copies of the classrooms along with hardcopy transcripts of the comments. However, the tapes and hardcopy were not used, even while the students were still making extensive use of the computer based system. Indeed, Pete indicated that he liked the control provided by the videodisk player, stating, "I like being able to replay what they did and hearing several different explanations for why they do certain things, It really gives us a chance to get to the nuts and bolts of teaching. It is one thing for someone, to tell us how to do it. It is something else to see someone doing it in a real world setting."

Pete also noted the value of the perspectives on the teaching that were provided: "I like having the comments of the teacher and expert commentary right there with the video. I get to hear their comments while what happened is fresh in my mind. I can play the video back immediately if I don't know what the comments are about." Other students echoed similar sentiments, saying,

> It is also beneficial to hear what teachers have to say about their own classroom practices. It's nice to know firsthand what seems to work and what doesn't. The comments the teachers make can really help a prospective teacher shape their own beliefs about what may or may not work in the classroom. (Donna)
>
> The feature I liked the most were the on-line comments, assessments, and critiques of the teacher. They are essential in giving a context to what is being viewed, and they really helped me to focus on why this teacher was better than most and the things that she did that were most (or least) effective. (Sam)

There were a large number of comments from the students praising STF for teaching them by example (and letting *them* decide what to make of the examples), rather than by telling them what good teaching should be. In effect, they told us that they recognized STF as the constructivist environment that it was designed to be and appreciated the fact that the STF experience aligned well with the philosophy of the rest of their teacher education program. Laura put it this way,

> We are learning in our classes to provide students with as many experiences as we can to help them develop strategies that are best for them. STF provides us with those same opportunities. We are exposed to many different teaching methods. By having these different experiences to learn from, I am better equipped to find what method is better for me.

Tina explained the same thing somewhat differently,

> I like the fact that taken together the system not only presents a variety of places, but an assortment of teaching styles and several commentaries on the advantages and disadvantages of each one. This helps you understand that good teaching is often a matter of opinion and you need to figure out what works for you. And it helps you do that.

In a later journal entry, Tina elaborated on her earlier comments about the importance of having a variety of exemplars:

> STF is helping me because it provides a means of comparison that I might not have had otherwise. I knew when I first saw Vickie's class that I did not like it. I did not know why. It was just instinct. It just did not work. But after watching David Birchfield I could see why I disapproved. It is like you do not really know what "hot" is unless you have experienced cold also. STF provides both and thus provides me with a means of seeing more clearly what I like and do not like and why.

Matt claimed that the natural anxiety experienced by all preservice teachers had been alleviated somewhat because he had seen multiple exemplars of good teaching.

> Using STF has given me another frame of reference to draw from while in the classroom; because of that, the level of anxiety that I am now experiencing is only a fraction of what it might have been, had I not experienced various strategies and styles via STF.

In a later journal entry, he claimed that STF had also helped him with self criticism.

> Being able to watch a larger variety of teachers has also helped me in the critique of my own ability. For instance, by watching a variety of teachers, I have found that I have a broader range of comparison, both for my own teaching and in evaluating their teaching.

However, most of the students agreed that the availability of more exemplars would improve the STF system considerably. As Tina put it,

> STF is really good resource, but without more teachers and lessons on it, it exhausts its possibilities after a while. It is such a good idea that I hope that the creators will add a lot more examples to it soon.

The instructor also indicated that the use of more exemplars over a wider variety of grade levels would be beneficial to students. With more exemplars, she could have students look at how teachers handle different mathematical concepts such as fractions, shapes, etc.. With only three lessons on the system, the opportunity to use it to support teaching of specific concepts is extremely limited.

STF as a curriculum component. One of our main concerns in this project was to learn how STF could best be used in a preservice teacher education course. In this study, STF was used as a "substitute" for field work at the beginning of the semester. It was seen as a way for students to "visit" models of teachers incorporating the NCTM Standards prior to being immersed in the field experience. One set of curriculum issues centered upon the placement of STF in the curriculum. Here, responses were generally positive — we seemed to have gotten it mostly right. The second set of comments, discussed STF relative to other components of the course. Here there was strong sentiment that STF is no substitute for actual classroom experience. The students' and instructor's commentary related to these issues follows.

The use of STF at the beginning of the course, prior to the students' placement in schools, was pointed out by several students as being a very appropriate use of the system. As Donna stated,

> I'm glad we were able to view Vickie and David before we began our field experiences because I think they gave us a framework of reference, or ideas, to work from. While we must each adapt our own teaching style, it helps to have ideas that "work" from practicing professionals.

Other students also recognized that the early introduction to Vickie and David helped to establish their early views about teaching. Sam commented that "Vickie and David helped me form my own early view about what teachers do, and what they should do. I'd never seen or experienced someone teaching like either one of them, but in retrospect, I really wish I'd had."

The instructor felt that the students "got off the mark a lot faster than the class I taught before" in regards to their understanding and reflections on mathematics teaching and teaching in general. She stated, "With doing workshops with them with hands-on materials and so on, so that by the end of two weeks, they already have a totally different picture of what math teaching is all about . . . and having used STF . . . they have that different picture." Despite this, she would like to utilize STF throughout the semester. Ideally, she would like to "be able to have it right in the classroom, so that on any day that we had our methods class, we could say, 'Let's break up right now and spend 15 minutes . . . .'"

While most students appreciated the use of STF, almost all believed that hands-on time in the classroom was even more valuable to them. Some students indicated in very strong terms that any time out of the classroom was wasted time:

> Now that I think about all the time we spent using it, we could have spent 4 more afternoons in the classroom — that would have been 12 more hours of practical classroom experience. . . . I did observe teaching and learning through STF, but I wasn't there. I couldn't walk around. I couldn't really see what all of the students were doing and I couldn't ask questions of the teacher or students. If I had a question other than the programmed responses that were provided, I was out of luck.

Gary echoed similar sentiments:

> Anything that kept us out of our classroom was less valuable than the classroom experience would have been and therefore, a sacrifice. I did enjoy watching the two STF videos, but would rather have done that in one afternoon instead of three.

Jennifer made a similar comment about the number of examples that students were able to analyze via STF vs. classroom observation during the same time frame: "Instead of watching those two [Vickie and David] teach the same lesson four weeks in a row, I would much rather have watched my teacher teach four different lessons." However, she goes on to say, "This is not to say, however, that I did not get any ideas from STF as to what I would like and would not like to do in my class — I did."

Other students recognized that while nothing replaced actually being in the classroom, STF did provide a useful substitute. As one student stated, "I truly believe that I need to be in the classroom to achieve full understanding of what is and is not effective; but this [STF] is a great substitute."

Gary had very strong sentiments about the expenditure of resources and funds used to create system of this type. He commented, "to me, STF is just another impediment to having a fifteen-to-one student-teacher ratio." He later expanded on this thought by stating:

> It's not that I dislike the lessons that I got from the STF, they were certainly useful. I just can't help thinking about all of the resources that were tied up delivering those two lessons. I don't think it's worthwhile. If I ask myself: "how much better of a teacher will I be for having been exposed to STF?," in all honesty, I have to answer: "not that much."

Use of STF was only one part of an entire course designed to get students to think about and practice teaching in the style of the NCTM Standards. This integration and focus of all aspects of the course to a common goal makes the contribution of individual components difficult, if not impossible to determine. Two of the eight case study students recognized and commented on this facet as well. Laura discussed how various components of the course opened up her mind to new ideas, stating "from my readings, . . . viewing the STF videos and in-class videos, and interviews, I am beginning to give kids credit and keep myself open because I think they will surprise me and exceed my expectations." Reflecting back on the course at the end of the semester, Matt commented on the integration of STF with the other aspects of the course in being fundamental in his growth:

> No individual experience in the math methods course would have been complete without the other sections to compliment it, and in that sense it seems to me that all sections of the course meshed together well and developed into a final product that was very conducive to understanding of mathematics in the elementary classroom.

How STF impacted understanding.

STF teachers as mental models. One of the primary goals of the course instructor was to provide exemplars of teaching math that the students could "see" since the cooperating teachers they were placed with may or may not be teaching in the spirit of the NCTM Standards. She felt that students would be able to "get a chance to do more than just see the classroom, but that they could sort of get inside the teacher's head, or get inside some other people's heads about what's going on." Student comments and observation of students in the field indicate that the teachers in the STF videos did serve as mental models of good teaching for the preservice teachers at the same time as they helped them develop their personal philosophies of teaching. As Sam explained,

> I can easily say that my exposure to David helped me to lay the foundation of my educational philosophy. He gave me a valuable reference point and standard to aspire to . . . . It really helped me throughout the semester to have David in the back of my mind as a baseline.

A comment in Matt's journal reiterates Sam's point: "I used the STF system as a frame of reference for each of my field experiences in one way or another throughout the entire semester."

In addition to keeping exemplars of good teaching in the backs of their minds, many of the students actually modeled at least some of the lessons they taught in their field experience classrooms after lessons they had viewed on the STF videos. For example, Sam used numerous features of David Birchfield's first grade measurement lesson in designing his own first grade lesson on place value. Some students even consciously imitated the STF teachers. As Matt admitted, "I guess we can't get much closer to modeling my teaching behavior about the STF than this, because I basically stole David Birchfield's activity. . . . I basically tried to be David Birchfield in this lesson." It turned out that Matt found using David as a mental model both helpful and distracting, as comments from his self-critique interview indicate. Matt opened the discussion of his teaching video with the following self-analysis,

> I think I was able to be relaxed somewhat in front of the class as a whole in this video, but when I was working with the students one-on-one, I was too concerned about moving around the room and trying to be like the model STF teacher.

Though Matt's use of STF as a model was purposeful, other students claimed that their use of STF models was not entirely a conscious decision. For example, Tina wrote in a journal entry that she was surprised how much STF images affected her teaching:

> I was very critical of Vickie at the beginning of the semester. But only a few weeks later I gave several lessons that were very much like hers and I returned to her in my mind as a consultant on how to improve.

Later, in the interview during which she analyzed her own teaching video, Tina elaborated on this comment.

> [At first] I hated Vickie Bill. I just hated it. I hated it, hated it, hated it — the whole approach. . . . I still have a few mixed feelings about her teaching, but the thing that's funny about it is that I feel like, in a lot of ways, my teaching has turned out a lot like hers. . . . As I look back, I'm seeing more and more the merit of her approach.

Tina was not the only student whose standards changed during the course of the semester. For example, Pete originally thought that David Birchfield was too stern with his students. After several weeks of field experience, Pete changed his mind. "When I look back at my observations of David Birchfield I think I was way too severe. . . . . I find myself being just as stern as he was in the video." Matt originally thought the self-critiques provided by STF teachers were too analytic. In time, he came to value the attention to detail that these critiques provided.

> Early on in the semester, . . . it seemed to me that they [STF model teachers] were too critical of their own teaching style and reading too much into their own actions. My opinion now contrasts sharply . . . It seems to me that attention to detail is a key factor in understanding the effectiveness of one's own teaching skills/weaknesses.

After teaching in his field experience classroom for weeks and after viewing himself on videotape Sam really appreciated the exemplary teaching modeled by the STF teachers. As he explained,

> I found [STF and self-videotaping] really, really useful. . . . They [STF teachers] make it look so damned easy . . . then when I saw my videotape and compared it, it was just like, "my god!" There was such a big gulf there. . . . That was really helpful. I really liked being able to compare [my] video . . . and the other ones.

Donna summed up the students' general reactions to the availability, through STF, not only of models of good teaching, but also of models of self critique:

> I would say it [STF] is most useful as an instructional tool, because it allows you to see other teachers "perform" in the classroom. It is very helpful to see, and hear, how teachers develop their lessons and also hear their comments on classroom management, how the lessons are progressing, etc.

The instructor recalled a specific instance where David Birchfield served as a mental model during a classroom discussion, "When we dealt with the session on counting and pre-number ideas, then I know that I referred to the things that they had seen in David's class . . . [STF] was so useful, because we had at that point a common reference of good teaching."

Specifics learned from STF. The STF system was not only effective in providing students with overall models of good teaching, but also in providing examples of a variety of specific strategies and techniques. For example, most of the students had very little experience with small group work in school, but they were anxious to try it in their teaching. They appreciated what they could learn about this new pedagogical technique from STF. As Matt commented,

> [From STF] I was able to learn specific group-related activities that I was able to apply to math activities for my second grade class. . . . I [also] drew the idea of assigning different roles to specific group members from the Dwight Cooley video on STF.

The students also mentioned how much they learned about effective questioning techniques by watching the STF videos and listening to the related perspectives. Sam put it this way,

> I really like the way that David Birchfield, when he's moving from group to group, his skill at questioning them is a lot better than mine. . . . I was walking around and kind of doing the same trick that I learned from him, which was keeping one eye open on everyone else and watching what specific ids are doing. . . . I really identify with the kinds of things I learned about from David Birchfield. He makes that kind of think look easy, . . . and it's not.

Laura appreciated the many management and organizational tips she gleaned from STF. She wrote, "After watching David Birchfield, I feel even more strongly about organization. . . . He had certain practices to identify transitions, like a song or the turning off of the light." Matt noted that he really had never given much thought to classroom management before observing hearing the STF teachers explain the management techniques they were using:

> I feel that one of the reasons I was able just to manage the students somewhat effectively in this lesson, is because of watching the STF video system and just getting a better understanding of how teachers can move around a classroom. . . . I was never really aware that I could actually have a strategy of moving around the classroom before watching STF.

He also noted that observing via STF had prepared him for most purposeful and effective observing in his field experience classroom:

> Vickie Bill was more influential in terms of learning effective management techniques through questioning, planning, and leadership. After watching Vickie, I was able to notice that my cooperating teacher had a similar situation of effective management established in her classroom. I was able to use my cooperating teacher's management system early in the semester, having been primed for such a thing by watching the STF.

Stimulating thinking about teaching. Watching STF not only gave the preservice teachers specific strategies to use in teaching, but also raised a variety of issues that they debated in class and wrote about in their journals. For example, many were anxious to know how Vickie Bill had set up her classroom at the outset of the school year. They admired the classroom's organization and the students' clear understanding of rules and expectations (as seen in the video clips of Vickie's teaching), but they wondered how that atmosphere had been established. As Sam put it,

> The most intriguing comment I heard on the disc is the one where she [Vickie] states that the first 5 days are used to set up her system and class the way she needs to. I want to know exactly what she tells those kids and what they do the first five days in greater detail. I'm sure there is lots of valuable info there.

Some of the students had just as many questions for David as for Vickie. The students seemed to think of Vickie and David as experienced colleagues and wished they were available for personal consultation or friendly teacher-lounge conversation. Writing in his journal, Matt expresses their sentiments well: "I would like to ask David a few questions. I have created a list that I would like to talk to him about, and will continue to add to it for the rest of the semester."

The students mentioned numerous ideas obtained from STF that they wanted to debate or to learn more about. For example, they were generally attracted to the notion of creating their own mathematics curriculum (rather than relying on a textbook), but concerned about how a teacher can actually manage to do this in practice (and whether they, as novices, could pull it off). In one of the STF perspectives, Vickie Bill explains that she uses student logbooks as a record of the ever evolving curriculum in her classroom. Gary commented in his journal,

> I love [Vickie Bill's] idea of using logbooks for texts. I hope after I've had a few years of experience under my belt, I'll have enough confidence and ambition to abandon the textbook and custom design my math lessons, or at least many of them. This way they could be tailored to the specific needs and abilities of the class.

Laura expressed similar sentiments:

> Another problem posed by STF is whether or not to even use a textbook like Vickie did not. It seemed to really work for her and her students, but I know at this time I am not even close to being able to work without a text.

Laura also noted, with a bit of surprise, that not all of her classmates reacted with the same enthusiasm to Vickie as a model. Laura appreciated a class exercise where students were required to justify their opinions about the effectiveness of the STF teachers by pointing to specific incidents in the videos.

> I thought Vickie Bill was more effective and that would be self evident to everyone. But this was far from true. There are those who found David's use of creativity better than what they perceived as Vickie's overly organized and hard to follow lesson. By making them and me give specific examples, hopefully we are better able to see how or why the other can think the way he does.

Summary and Discussion

Our focus in this study was to document how the Strategic Teaching Framework (STF) could be used in a teacher education course to provide models of teaching-in-action about which prospective teachers could reflect and debate. Our goal was to facilitate the development of teachers comfortable with teaching according to the recommendations of the NCTM Standards and thoughtful about their development as flexible practitioners. Our setting for the study was the field experience component of a masters certification program for prospective elementary teachers. Our data documented how the students used the technology, as well how they planned and taught lessons to actual classes of students and how they reflected on teaching and learning issues in class discussions and in their individual journals. We were not surprised to observe that, as novice teachers, the PSTs were not able to teach lessons that came up to the standards they had learned about. Therefore, documenting the PSTs' growth in reflective understanding across their analyses of these very different types of teaching episodes was of particular interest.

We are still interested in exploring further how STF could best be utilized in this course. Its use at the beginning of the course allowed the students to have a "virtual" field experience. Many students commented on its importance in providing an early model for them to draw upon. However, other students felt that the time spent on STF (four hours a week/three weeks in row) was too much. We wonder if STF would be better utilized if it were interspersed throughout the entire class as opposed to loaded at the front end.

One of the students (Laura) devoted much of her journal to discussion of age appropriateness. In particular, she wondered if the differences she saw between David and Vickie's teaching strategies and styles were due to the differences in the ages of their students. Other PSTs also mentioned that they wish they had a specific exemplar of the grade level they were working with. We are curious as to the importance of specific grade-level exemplars. How close to the students' actual situation do video models need to be? What aspects of teaching transfer across grade-levels and which are better served by specific age (or for that matter, content) exemplars?

In any case, from the way in which STF was incorporated in this class we learned the following. PSTs were avid users of the STF system, prolific and thoughtful writers of journal entries, and eager participants in discussions about what they gained from use of STF. In a number of cases, the lessons that they taught in the schools were explicitly modeled on lessons viewed in STF—and in their self-critiques of these lessons the PSTs provided rationale for their choice of lesson and reflected thoughtfully on how and why they had adapted these models. Our PSTs reported (and evidenced) important changes over the course of the semester in their views of mathematics and of what constitutes effective teaching. The teachers in the STF system proved to be important models for the PSTs, while the commentary provided within the system provided a springboard for student reflection and discussion both in their journals and in the class. An important side benefit STF provided was its use as a common image and reference point for the students. Throughout the semester, students were able to refer to specific instances in the videodisks or comments made in the commentaries and generate discussion with everyone else in the class since everyone understood the reference.

To be effective, teacher education programs and classes should model what they teach. We feel that integration of STF into this field experience provides students with important models outside of the teachers on the videos. First, it models an appropriate use of technology that allows students an experience they could not have had otherwise. The technology in this instance extends their boundaries of observation and experience far beyond the traditional field experience, allowing them to see and communicate (via the perspectives) with expert teachers. If teacher education classes do not model appropriate uses of technology, then we cannot expect new teachers to develop an understanding of technology's potential, for both good and bad,in their teaching. Additionally, the constructivist framework underlying the design of the software is consistent with the philosophy and goals of the Standards. This provides another important, if subtle, model for the students. As they work, grow, and construct their own ideas about teaching, STF provides a learning environment which exemplifies the goals of the Standards. Learning in this environment can help the students understand the meaning of "constructing knowledge" and help them to be better able to create similar experiences for their students. While we recognize that it may be impossible to isolate the influence of STF from other influences on our PSTs (methods instruction, class discussion, school observations, etc.), we feel confident, nevertheless, that use of STF contributed significantly to the M501 field experience.

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Title:

The Process of Developing Theories-in-Action with OELEs: A Qualitative Study

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Introduction

Open-ended learning involves self-directed processes that are driven by the unique intentions and purposes of learners. Contemporary learning theory such as constructivism (Jonassen, 1991), situated cognition (Brown, Collins, & Duguid, 1989), and cognitive flexibility (Spiro, Feltovich, Jacobson, & Coulson, 1991) emphasize the active role of the learner in constructing understanding. Furthermore, theoretical perspectives about student-centered learning have become increasingly foundational for contemporary technology-based environments such as microworlds (Papert, 1993) and anchored instruction (Cognition and Technology Group at Vanderbilt, 1992). Open-ended learning environments (OELEs) have been touted as one approach for blending learning theory and emerging technology to support the process of building and evolving student-centered understanding.

OELEs use technology to create experiences for learners to build and test their intuitive notions about the world. Microworlds, for instance, use technological environments wherein learners can begin exploring and building upon intuitive models (Rieber, 1992). OELEs are based on an assumption that learning is a continuous and dynamic process that constantly evolves as a result of a learner's observation, reflection, and experimentation (Hannafin, Hall, Land & Hill, 1994). OELEs are designed to provide experiences for learners to identify, question, and test the limits of their intuitive beliefs and theories. As such, the learning process involves developing a *theory-in-action*--an intuitive theory that is generated and changed by learners as they reflect upon experiences that either confirm or challenge the validity of the theory (Karmiloff-Smith & Inhelder, 1975).

Piaget (1976) characterized the learning process as one that occurs through continuous testing and reconciling of beliefs in the face of ever-changing experience. Understanding is constructed from initial intuitions that are built upon by learners as they encounter experiences that lead them to question the adequacy of their "theory." Once the theory is questioned, understanding develops as learners confront their theory through a series of actions designed to test it. Corrections to the theory can be made as learners connect thinking and action by testing the limits of the theory.

The Problem

The process by which learners use OELEs to build and evolve new models of understanding has not been studied extensively. Despite the theoretical ideals of OELE's, the process by which learners interact with these systems to build an initial theory, test it, and revise it remains unclear. Some studies have indicated that learners do not use system features in ways conducive to building understanding (Atkins & Blissett, 1992). A greater understanding of how learners use OELEs to build and evolve theories-in-action is needed.

Previous research has provided little insight into the *process* used by learners to build and evolve theories or models of understanding. This study was less about examining the extent of a learner's understanding than about empirically documenting the dynamic process of conceptual development as it occurs in conjunction with an open-ended learning environment. The study qualitatively examined how the organization of learner actions within an open-ended system gave rise to new understanding that regulated the development of a theory-in-action.

The Purpose

The purpose of the study was to investigate how theories-in-action develop in collaboration with open-ended learning environments. The study examined the following questions:

1. What processes are used by learners to build and/or evolve a theory-in-action?
2. What intentions are used by learners to build and/or evolve a theory-in-action?
3. How do learners use system features to build and/or evolve a theory-in-action?

Method

The participants were 4 seventh-grade students drawn from a general science class. The students were studied as separate cases. The learners included two boys and two girls. The OELE was the *ErgoMotion* level III interactive videodisk (mechanical physics), which combines computer-generated graphics, computer simulations, video and print-based materials. The content of the OELE is physics (force and motion), and learners construct understanding of these concepts by designing a roller coaster. Learners use the environments by manipulating variables such as amount of mass, curve radius, and hill sizes. Informational resources are also embedded into the program such as on-line consultants and a "videopedia." The primary techniques for collecting data included think-aloud protocols, observations, and interviews.

Learners used the system for approximately four hours, and the sessions were videotaped and later transcribed. Interviews took place approximately one week later, and learners were given analog problems of physics concepts, a perception of open-ended learning questionnaire, and a feature knowledge questionnaire. Learners were led through videotapes of their sessions, and were asked to clarify their thinking and intentions. Interviews lasted approximately 2 hours.

Findings and Implications

Findings were organized according to an analysis of system-based events, learner processing of events, and learner intentions for action. The analysis used detailed data from verbal protocols to examine individual actions and the intentions and processes that gave rise to them. The goal of the analysis was to identify and represent how actions, processes, and intentions formed on a micro-level during open-ended learning, in order to derive a theoretical framework to better understand cognitive processes at a macro-level. The data were assigned to categories that represent the extent to which a learner builds and evolves a theory-in-action.

Question 1: What processes are used by learners to build and/or evolve a theory-in-action?

This question examined the extent to which a learner processed system feedback resulting from taking action. Three levels of processing distinguished the ways that learners processed information during theory development. Specifically, learners *perceive* relevant conceptual information, *organize* the information around interpretations or explanations, and *integrate* information with existing prior knowledge (Mayer, 1989). Responses were identified as instances of processing if they represented cognitive reactions to information or feedback provided by the system.

Perception. At a minimum, all learners processed information at the perceptive level. Most learners recognized the effects of their actions on system events. For instance, one learner perceived visually that variations in mass and horsepower resulted in less time for the coaster to reach the top of the first hill:

> I thought that the more mass that was in there [with a 50 versus a 25 horsepower engine], it took it a while to get up there. So I'm now going to change the horsepower to 100.

In this case, he selected the information that was relevant (i.e., changed the horsepower), and derived conclusions regarding its effect on the coaster. This learner used observational data generated by the system to draw a valid conclusion about this observation.

Learners often made valid conclusions concerning their observations, in the form of either success or failure of the coaster, or verbal or numerical information provided by the system. On the other hand, learners frequently drew erroneous conclusions based upon their observations. Learners frequently confounded visual information with judgments based upon subjective, naive, incomplete or inaccurate visual information. Confounded observations were frequently used to describe the behavior of the coaster in subjective and inaccurate ways (e.g., "It's gaining speed at the very end"). For instance, after lowering the horsepower and observing the coaster crash, one learner concluded, "It went further this time [around the curve]." Objective data for drawing valid conclusions (i.e., the coaster crashed) were confounded with subjective perceptions of visual information (i.e., it went further). In this instance, perceptions of inaccurate data resulted in erroneous assumptions about the effect of horsepower on the speed of the coaster (i.e., it went further after lowering the horsepower; therefore, horsepower must affect speed).

Organization. Most learners attempted to assign meaning to system events by generating interpretations, expectations, or evaluations based on system feedback. Learners used organizational processes to establish simple cause-effect relationships and expectancies. For instance, they learned quickly that when the coaster moved rapidly during the simulation, it was likely to crash. Thus they formed a simple expectation that was easily confirmed, based on whether or not the coaster crashed. Statements of expectancy such as "It's going to fall off," "I didn't think it would make it," and "I knew it would go over" were used often used to establish and confirm rudimentary expectations about whether or not the coaster would "work."

Eventually, learners used information from the system to form simple cause-effect relationships. They provided a reason or cause for a system event (e.g., "Yeah, it was probably too much horsepower going up..."). Simple cause-effect interpretations were usually based on intuitive ideas about the cause of a coaster crash. For instance, one learner tried to stop the coaster from crashing for several trials before offering an explanation: "I figured out what I did wrong. There wasn't enough weight." Based on this interpretation, she took action to increase the mass. In a similar instance, another learner remarked, "I think the engine's too [powerful]," and lowered the horsepower accordingly. In these instances, learners offered an explanation for the event, but did not provide observational evidence to support their interpretation. However, the interpretation or expectation was used to take future actions.

Learners frequently interpreted system feedback based upon preconceived assumptions or beliefs. To illustrate, one learner's subjective interpretation of system data was evident in his statements about the role of mass and speed: "I think that with more people, it went a little bit slower than what it did without less people ... The more mass you have on it, like the slower it will go." During his next interaction, he changed the hill sizes "to get more speed" and decreased the mass. He remarked,

> I'm going to try it with no people on it...with the same engine ...[runs simulation; coaster is successful] Hmm... It went faster than the one with the people on it....Yeah, I think it might have [gone] faster than the one with people on it, but because of the hill size I have, with the smaller hill up here (hill 3), it went slower, a little bit, than it could have went.

In this instance, he appeared to interpret visual cues from the system in ways that were consistent with his intuitive assumptions about factors affecting the speed on the coaster (in this case, mass). The consequence of his intuitive perceptions was faulty interpretations regarding causes and effects. In such situations, it appeared that learners "saw" what they intuitively expected to take place, and consequently derived perceptions and interpretations of visual cues that were consistent with these assumptions. Consequently, learners were often unable to use system feedback to further revise and refine interpretations.

Learners also elaborated and/or confirmed expectations using intuitive assumptions and beliefs not generated from objective data. They tended to elaborate and change interpretations in ways that were consistent with their intuitive expectation. When an expectation was not confirmed by system feedback, learners often changed or added to interpretations, in order to make them consistent with the new data. For instance, one learner encountered the following actions, each of which was sparked by inconsistencies between observed data and expectancies:

> I'm going to put more weight on there. So it's like a full cart, I guess. [runs simulation] It's going to go off that track. [crashes]. I guess you just can't have that much power on. I'm going to put a smaller engine on there... So with a smaller engine, I think it will stay on the track. [crashes]. I think since it had so many people on it, ... it makes a lot of force ... with all the weight.... I'm going to try it with less people... Maybe it will stay on. [crashes] .... I guess .. even with the smallest engine, all that weight on it, is... playing a big part in making it go off.... With an engine with no people on it, I don't think it would go off. Yeah, if it didn't have any people in the cart, it wouldn't go off. I'm going to try it with a little less people in it. [crashes] Now I know ... now I think it's like ... I think it's the *hills* [italics added] now. Cause even with less people on there ... with the real steep hills, it's getting too much speed.

When expectations were not confirmed, this learner appeared to either create new expectations or add to the previous ones in ways that preserved his underlying assumptions. As inconsistent data continued to challenge his assumptions, his expectations about the importance of mass and horsepower may have weakened, but were not altered. This was further evidenced by an interaction that took place shortly after, when he tried to determine why the coaster did not ascend the third hill.

> It didn't even have enough power to make it up that real steep hill. So, I'll make [hill 1] steeper...[goes to energy loading] Well let me try something. [changes horsepower from 25 to 50] I think it might have more power now, and then I can leave it like that and it might go over. [coaster does not make it over hill 3]... Well, I think I'll not make [hill 1] the steepest ... but make it a little bit steeper.

He returned to his assumptions about horsepower to interpret events and guide future actions. These examples suggest that powerful intuitive assumptions drive both interpretations about the reasons for actions and decisions about future actions, and are not easily altered.

Integration. Integration involved connecting actions, concepts, or system events to prior knowledge or relevant personal experiences, which were used to interpret, evaluate, or supplement conceptual understanding. Integration relationships were evident in references to analogies, metaphors, or concrete personal experiences (Mayer, 1989). In comparison to other processing levels, learners showed little evidence of integrating system events. Those who integrated often used their experiences of riding roller coasters to elaborate the data. Sometimes, however, prior experiences with roller coasters contradicted the system experiences. For instance, the solution to one of the "coaster challenge" problems was to arrange the sizes of three hills so that the coaster would roll backwards down hill 3, roll backwards over hill 2, and come to a rest in valley 1. One learner initially wanted to attempt this, but remarked:

> Oh yeah. It's got brakes, it can't roll backwards ... They told us that because there was this one lady who was freaking out before we went on a ride. And they said, "it's got automatic brakes along the edges, and it if stops, it will clamp and you'll hang."

She continued to make references to brakes and clamps during remaining use of the system when addressing issues of slowing down and stopping. Prior knowledge, in this case, appeared to limit interpretations and future actions due to inconsistencies between personal experience and the environment.

Two learners related observations or interpretations to personal experiences. In reference to information provided by a consultant on acceleration, one learner remarked: "I was thinking about when you're in a car or something, how when you like go faster ... it will like push you back in your seat, and when you come to a stop sign, you will go forward." After listening to information from the on-line consultants on "what affects acceleration," he added: "I've got a dirt bike, and when you go faster, it kinda pushes you back ... like pushing on you a little bit." In this instance, he clearly linked the concepts presented in the system with his own personal experiences.

Question 2: What are a learner's reasons intentions for building/evolving a theory-in-action?

Intentions represent a *reason* for action. Intentions *can* mediate a learner's actions and the processing of information resulting from them. Three levels of intention distinguished the ways that learners used information to regulate future actions: Unsystematic, goal-based, and means-based. In unsystematic searches, learners browsed the system with no apparent intention to either meet a specific goal or understand relationships. With goal-based intentions, learners focused on taking specific action to meet a specific goal (i.e., to make the coaster "work"). Means-based approaches focused on taking action to discover *why* an event is occurring or what *could* happen if limits were extended. The search for means implies a goal of confirming or refuting a theory (Karmiloff-Smith & Inhelder, 1975).

Unsystematic searches. All learners conducted unsystematic searches during the learning process. Such intentions often took the form of "browsing" the system features and trying to determine their functions (e.g., "...see what this does."). Often, unsystematic intentions were manifested in situations where uncertainty existed about how to solve a problem. For instance, one learner explored the menu bar and attempted to use a video grabber tool to help him solve the problem. He stated, "I don't know what that is ... I'll try it I guess." Still unable to solve the problem, he later tried the grabber tool again, and frustrated, remarked, "What is that *grabber* [italics added]?"

Goal-based intentions. The focus of goal-based intentions was to find out what "worked" and to take subsequent actions. Learners often set goals and took actions to meet them, noting actions that did, and did not, prove successful. For instance, after a coaster crash, one learner remarked, "Well, I found out what hills don't work here." He then wrote down his "answer" and left the coaster site shortly thereafter to "[go] back to my questions and answer another one." In these instances, goal-based approaches were used test ideas about what might work. The reasons for success were not addressed; rather, information about the success was noted and recorded for later reference.

Means-based intentions. All learners demonstrated means-based intentions, but to varying degrees. Means-based intentions were identified when learners developed new intentions to explore the limits and boundaries of actions, rather than focusing on what is "known" to solve the problem. For instance, one learner had the following interaction:

> [coaster crash] I figured that might happen. Yeah, it was probably too much horsepower going up and all ... When you first start off going up the hill, it's pushed so fast, and you've got all that force from the first hill, because I made it real steep ... [changes horsepower to 25] I made it so I dropped the horsepower of the engine, and I made the first hill smaller, so it will probably stay on the track. [coaster makes it]

In this instance, Jason elaborated a clear expectation or theory as to why the coaster crashed, and offered an alternative he anticipated to result in success. Following success, he continued exploring alternative solutions:

> [makes curve small and runs simulation] I think it's going to go off the track. [crashes]. Well, yeah, with that sharp of a curve, and it had that much speed going... I'm going to make [the] hills smaller, so maybe even with the sharper curve, it will stay on the tracks. [coaster makes it] I kinda figured that one [would work], 'cause ...the first hill was not ... so steep... [changes mass to 6000]. I'm pretty sure this one will stay on. With that many people on there, it will... make it slower and all. Yeah, and... maybe also because [the first hill] wasn't very steep.

During this interaction, he acknowledged that the sharpness of the curve caused the coaster crash. However, rather than changing the curve, which would be the likely choice for success, he changed the hill sizes to explore the limits of the curve's capabilities. In this instance, this learner appeared to evolve his intentions from choosing the most likely solution to finding alternative solutions.

Question 3: How do learners use system features to build and/or evolve a theory-in-action?

Feature use distinguished the ways learners responded using the features and functions of the system. Feature use was defined operationally as the way in which learners used the system to meet a goal or intention. Three categories were developed: (1) general awareness of the existence and function of a feature; (2) awareness of how to use a feature to achieve a desired goal; (3) awareness of how to use a feature to build, test, or evolve a theory.

General awareness of existence and functions of a feature. During the interviews, learners were asked questions about their awareness of system features. All indicated at least minimal awareness of primary system features. Even when system features were not used, learners responded in the interviews that they knew that they existed. For instance, none of the learners except one used the coaster's features to gather numerical information about the speed, g-forces, kinetic and potential energy, and acceleration at given points along the track. One learner explained his awareness and reasons for not using them:

> Researcher: There are data points under the options menu, and it puts these little hot spots all along the ..
> Learner: Oh yeah, yeah.
> Researcher: So you knew about that. But you didn't use it.
> Learner: Yeah ... I guess I just didn't think I needed those data points to help me. I think that if I really thought about it, I could just figure it out on my own.

Another learner responded in a similar manner, noting " .. I guess I just thought I could manage without them." Such responses may imply that learners view system features other than primary manipulation tools as needed only for assistance.

Awareness of how to use system features to meet a goal. Feature usage was most apparent in situations where learners verbalized a specific intent or goal, and then told how they would use the system to achieve it. At other times, learners perceived that the system *could not* provide the information needed to meet a goal. This was evident even when the system could provide the information desired, but learners were unable to recognize that the information was accessible. For instance, one learner stated, "I wish I knew what motor we were using on this." [Although the information was not displayed at that moment, it was available in a different section (at the energy loading section)]. This learner did not know how to maneuver the system resources, tools, and features in order to solve her problem, even though she was aware that the features existed. In this case, the system provided neither the information she sought nor cueing to possible features for answering her questions.

One learner encountered a situation where the information *was* immediately available, but was not represented in a form she could recognize. As the following interaction illustrates, she did not find the information useful:

> [sets hill heights at hills and valleys section] Yeah, that would be fine, it would just take them longer ... to cover the track. I wish .. it would tell me how much time it would take ... Well, I can look at the data points. [views data points, then runs simulation]. Oh I wish it would tell me the time it took for it to run the full course ... Then I'd be able to tell which one was faster.

The information on the roller coaster's speed was available for each point along the track. This learner, however, sought a specific form of the data, one that was not represented.

Awareness of how to use system features to build, test, or evolve theory. Awareness of how to use the system to develop and test hypothetical situations was not apparent. Learners offered theories or reasons for the consequences of an event, held that predicted variable constant, and intentionally tested it using manipulation tools of the system. However, they did not use system features to derive and test hypothetical problems or to derive counter-examples to confirm or refute a theory.

One learner, for instance, often used the system to test and revise hypotheses:

> [sets hills] I'm not sure if it will even make it over the hill. [coaster stops at top of hill 3] ... 'cause that first hill is like shorter than the third hill ...[changes hill 1 to medium; stops at top of hill 3] Still didn't make it. Add more horsepower to it [changes horsepower from 25 to 50]. *Still* [italics added] didn't make it ... Change the weight on it [changes mass from 6000 to 4000 kg]. I think it will make it over now. [stops at top of hill 3]. Yeeee... nope. [changes mass to 20000 kg.; still does not go over hill 3]... Well, if I change the horsepower, it might make it over the hill. [changes horsepower to 100]. [stops at top of hill 3]. Still didn't do it. Change the ... hills I guess.

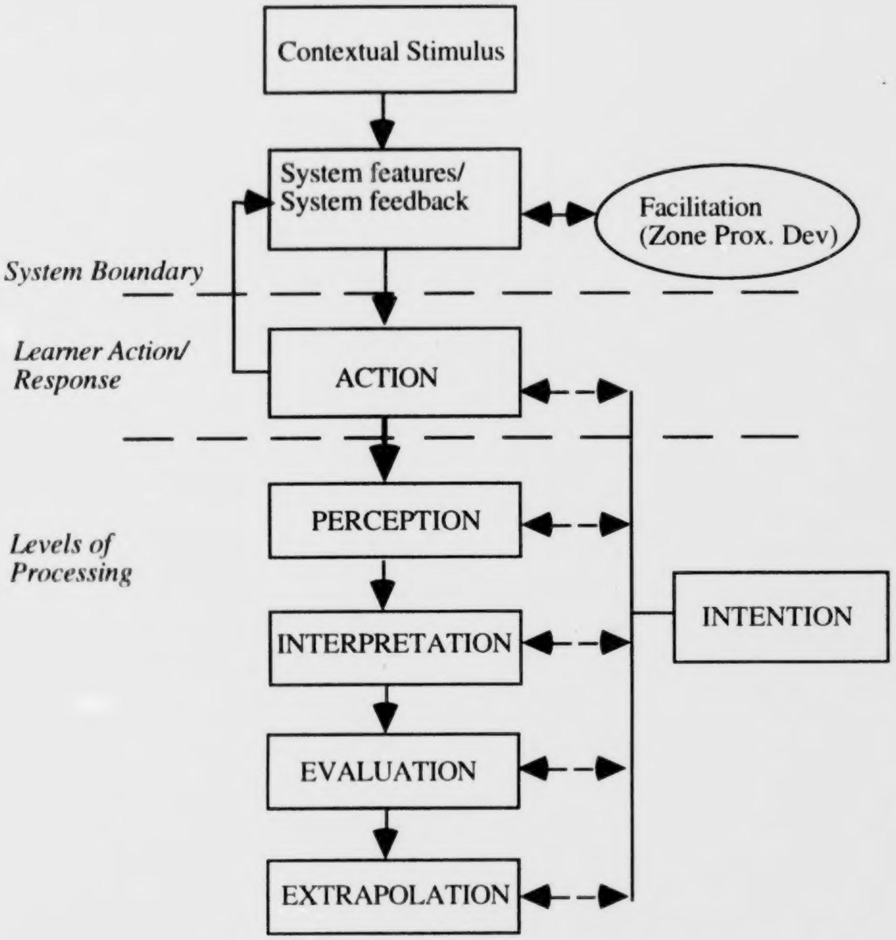
After lowering hill 3, the coaster run was successful. However, despite evidence that could be used to question the validity of his horsepower theory, this learner did not use the system to confront his faulty assumptions. That is, he did not try to construct a hypothetical counter-example to see if the horsepower affected acceleration in the ways he believed. It is also interesting to note that this learner successfully answered a question in the Science Talk Show about the whether doubling the size of the motor was necessary if doubling the hill size. It appears that he acknowledged the relationship between horsepower and acceleration on an abstract, conceptual level, but did not recognize the information as counter to his theories about horsepower. Due to apparent difficulty in recognizing counter-examples, it is not surprising that learners failed to use the system to systematically construct and test them.

General Discussion

The process of developing theories-in-action in conjunction with OELEs appears to center around three primary areas: Decisions about how to use the system, processing of system-generated feedback, and intentions for further action. The more closely linked these three components, the more likely a theory-in-action will develop and evolve. The model presented in Figure 1 illustrates the interplay between the system and the learner in developing a theory-in-action.

Figure Captions

Figure 1: A conceptual model of the theory-in-action development process


Contextual Stimulus
System features/ System feedback
Facilitation (Zone Prox. Dev)
System Boundary
Learner Action/ Response
ACTION
Levels of Processing
PERCEPTION
INTERPRETATION
EVALUATION
EXTRAPOLATION
INTENTION

The model predicts that as learners progress in their understanding, underlying theories are built, confirmed, and/or refuted. An initial theory-in-action is *built* iteratively through basic levels of processing, perception and interpretation, which are informed through learner intention and action. Learners *perceive* relevant information from the system, use their intuition and prior knowledge to provide *interpretations* to explain system events, and establish *intentions* to take *action* using system features to test their interpretations. A refined theory-in-action *evolves* as learners: (1) *perceive* information as consistent or conflicting with their theory; (2) *interpret* a new theory or elaborate an existing one; (3) *evaluate* the validity of the theory using new data; (4) *extrapolate* alternative rules or explanations; (5) use *intentions* to expand the predictive boundaries of the theory; and (6) take *action* to test their previously-held or new theory. The study uncovered several prominent findings with significant implications for understanding how learners build and evolve theories-in-action with OELEs.

The Resilience of Theories-in-Action

An important implication of the study is that theories-in-actions were extremely resistant to change. Whereas learners showed evidence of building theories-in-action, they did not appear to evolve them significantly. Through interaction with the system, learners became more *aware* of their intuitive theories by using them to explain system events; they did not, however, recognize limitations in their predictive value and attempt to refine them further. Learners hold powerful personal theories that often dominate cognitive processes and actions with OELEs. Even with system tools to manipulate and evolve conceptions, initial learner theories remained largely unchanged. Learners did not use system tools to manipulate the theories; instead, they tended to manipulate the system and interpretation in order to preserve them.

The Over-Reliance of Visual Cues from the System

Another prominent finding was that learners relied heavily on the video simulations to provide feedback about a previous action. Learners used the video segments literally to estimate the speed of the coaster during the simulation and the probability of its crashing (if it was moving rapidly on the simulation, it would crash). Learners also used visual cues to interpret the speed of the coaster, and judge relative differences in speed.

A reliance on the literal interpretation of visual cues is likely due to novice learners' focus on superficial or surface features of a problem (Chi, Glaser, & Rees, 1982). It is often difficult for novices to select relevant information, and they typically interpret visual symbols as relevant (Petre, 1995). Accordingly, novices confuse visibility with relevance, and focus on obvious visual cues, without considering the underlying logic of their selection. This tendency is possibly influenced by frequent exposure to television, videos, and computer games, where learners have adapted to processing obvious visual information without considering deeper meaning.

In the present study, reliance on visual cues was damaging to theory building because the system feedback provided inaccurate simulations of speed. Consequently, learners misperceived the fidelity of the images, and as such, built initial assumptions and theories that were incorrect and difficult to alter. Without accurate and more precise representations of speed, learners could not evaluate limitations in their thinking. When ambiguously-presented data are interpreted literally by learners, theory evolution is stunted due to misrepresented feedback ultimately perceived by learners as valid.

Another consequence of relying on ambiguous and inaccurate visual cues was to "contaminate" or bias learner interpretations (Wilson & Brekke, 1994). In the present study, learners often perceived inaccurate and ambiguous visual information, and used it to preserve or confirm their thinking. For instance, learners typically believed that increasing the mass increased the coaster's acceleration. After running the simulation, they often inaccurately concluded that the video feedback supported the belief (e.g., "...it went faster than the one with less mass"). Consequently, over-reliance on visual cues not only influenced inaccurate theory building, it also preserved it.

The Situated Learning Paradox

One assumption underlying the design of OELEs is that learning is optimized when it is situated in an authentic context (Hannafin et al., 1994). Learning is facilitated when experiences to connect prior and everyday knowledge to new contexts are provided (Choi & Hannafin, 1995). As learners connect system-derived experiences with prior knowledge, they access existing frameworks to be built upon and used to support new understanding. This knowledge can then be used to enrich or elaborate system experiences and intuitive theories.

OELEs use authentic contexts to facilitate the linking of system events to prior knowledge. For instance, the roller coaster site is authentic in that it embeds relevant knowledge and skills and assists learners in connecting system experiences to prior knowledge (most children are familiar with roller coasters). While links to prior knowledge enhance the potential for transfer (Brown, et al., 1989), it also increases the likelihood that learners will draw upon incomplete and often inaccurate understanding which form the basis of faulty theories. Findings from this study indicated that learners often referenced prior knowledge and experiences that either contradicted, or interfered with, the system's treatment of the concepts of force and motion.

Fragmented prior knowledge affects how information is interpreted and actions are taken. For instance, in the present study one learner recalled a roller coaster operator telling her that the coaster had brakes and could stop mid-ride. Consequently, she used this information to interpret feedback and drive future actions. As a result, she often interpreted the coaster as slowing down around curves because of her belief that the coaster used brakes. In this case, a belief that the coaster slowed down around the curve (because of brakes) interfered with an understanding of force and motion in a context that did not support exploration of the notion.

In sum, despite evidence of evolution of theories-in-action, this study indicates that newly evolved theories are fragile and easily abandoned. The strength and persistence of intuitive theories-in-action, in the face of conflicting experiences, raises questions regarding the nature and process of learner cognitive development.

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Title:

Student-Centered Learning Environments: Foundations, Assumptions, and Implications

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Introduction

Traditional instructional approaches, as well as the systems design processes that support them, have been criticized for failing to reflect contemporary thinking about teaching, learning, and technology. Several perspectives have emerged regarding the role of instructional systems design in supporting critical thinking and problem solving. Many believe that instructional design methodologies, themselves, are not inherently limiting. Limitations, it is argued, result from narrow interpretation rather than inherent shortcomings in the approaches themselves (Reigeluth, 1989). Others advocate extending or adapting traditional design methodologies to better accommodate diverse perspectives and contemporary research and theory (Lebow, 1993; Rieber, 1992). Still others disagree, noting that many objectivist assumptions and pedagogical requirements of "instruction" are fundamentally incompatible with non-objectivist viewpoints (Cunningham, 1987; Kember & Murphy, 1990). The need for enlightened uses of technology to support alternative approaches is apparent. Student-centered learning environments have been touted as one alternative.

Student-centered learning environments provide interactive, complimentary activities that enable individuals to address their unique learning interests and needs, examine content at multiple levels of complexity, and deepen understanding (Hannafin, 1992). Contemporary environments create multidimensional, ecologically valid systems where students access existing, or build new, conceptual linkages. They establish conditions that enrich thinking and learning, and use technology to enable a multitude of methods through which the processes can be supported.

Unfortunately, research on the many forms of computerized learning environments has been sparse. Empirically-based design guidelines have rarely been offered, resulting in a host of diverse applications of technology but not what Glaser (1976) described as a "science of design." The purposes of this paper are to provide a brief overview of learning environments and to identify the foundations and underlying assumptions of learning environments.

Overview

The concept of a learning environment is not new. Its roots can be traced to early apprenticeship, Socratic, and similar movements that have sought to immerse individuals in authentic learning experiences, where the meaning of knowledge and skills are realistically embedded (Dewey, 1933; Pask & Boyd, 1987). Recent perspectives have expanded, seeking to change the nature and breadth of experiences made available to learners and in the capacity to mediate these experiences electronically (Papert, 1993). Designers have operationalized learning systems of enormous power and sophistication based upon redefined notions of learner-knowledge relationships. Contemporary learning systems reflect research and theory ranging from situated, contextual teaching and learning (Brown, Collins & Duguid, 1989; Cognition and Technology Group at Vanderbilt, 1992) to cognitive flexibility (Spiro, Feltovich, Jacobson, & Coulson, 1991). Comparatively few applications, however, have unleashed the potential of either the technologies or learners. A need to optimize the capabilities of both emerging technologies and learners is apparent. A clearer understanding of the roots of alternative approaches is needed.

Foundations of Learning Environments

Various learning environments can be classified according to the manner in which they manifest their underlying foundations. Learning environments are rooted in five foundations: Psychological, pedagogical, technological, cultural, and pragmatic. All learning environments explicitly or tacitly reflect these underlying models or foundations.

Psychological foundations are rooted in beliefs about how individuals think and learn. Contemporary learning environments draw upon psychological foundations from areas such as constructivism (Jonassen, 1991), situated learning (Brown, Collins, & Duguid, 1989), and cognitive psychology (APA, 1992). Pedagogical foundations, on the other hand, emphasize how knowledge is conveyed. Pedagogical influences focus on the methods, activities, and structures of the learning environment. Student-centered learning environments often draw upon pedagogical approaches such as problem-based contexts (CTGV, 1992), and opportunities for experimentation and exploration (Tobin & Dawson, 1992). Taken together, psychological and pedagogical foundations provide the basis for the methods and strategies employed, and the ways in which the to-be-learned content is organized.

When technological foundations are considered, they emphasize how the capabilities and limitations of available technology can be optimized to create an environment likely to engender the kinds of learning desired. Technological capabilities constrain or enhance the types of learner-system transactions that are possible. The challenge for designers is to capitalize on the capabilities of emerging technologies, while generating new designs rooted in emerging psychological and pedagogical research and theory.

Cultural foundations reflect prevailing beliefs about education, values of the culture, and the roles that individuals play in society. In turn, they affect the design of learning systems by forming the underlying value systems that guide design methodologies. For instance, both educators and society recognize the need for educational system that adequately meet the knowledge requirements of our rapidly expanding technological society. Computers are prevalent in most classrooms and educational software is widely available -- schools are beginning to mirror the values and priorities of a technological society.

Pragmatic foundations reflect the practical constraints of the environment. Each setting has unique situational - constraints that affect the design of learning systems. Issues such as run-time requirements, hardware/software availability, and financial concerns significantly influence the adoption and diffusion of innovations. They emphasize the practical reasons a particular approach should or should not, or can or cannot, be used in a learning environment.

The five foundations are functionally integrated in learning systems designs. The better integrated the foundations, the greater probability of success in the setting for which it is designed. However, if one or more of the foundations is not conceptualized in conjunction with the others, complete integration is not possible. For instance, an environment rooted primarily in technological capabilities (e.g., the use of the Internet in the classroom) may be limited in that it excludes consideration of other foundations; attention must also focus on how technology can support desired thinking, convey information, reflect cultural beliefs, and meet pragmatic requirements. As shown in Figures 2a - 2d, failure to account for all foundations interactively causes predictable threats to the integrity of the environment.

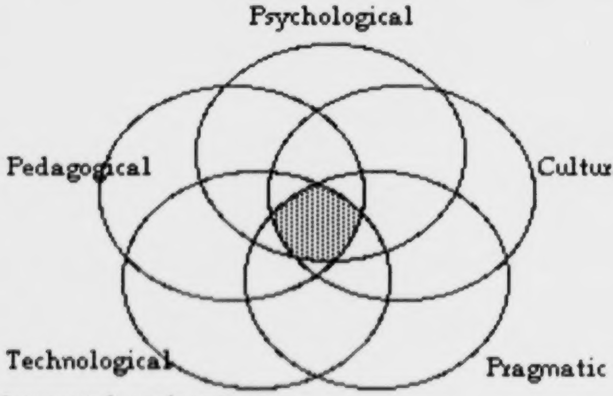
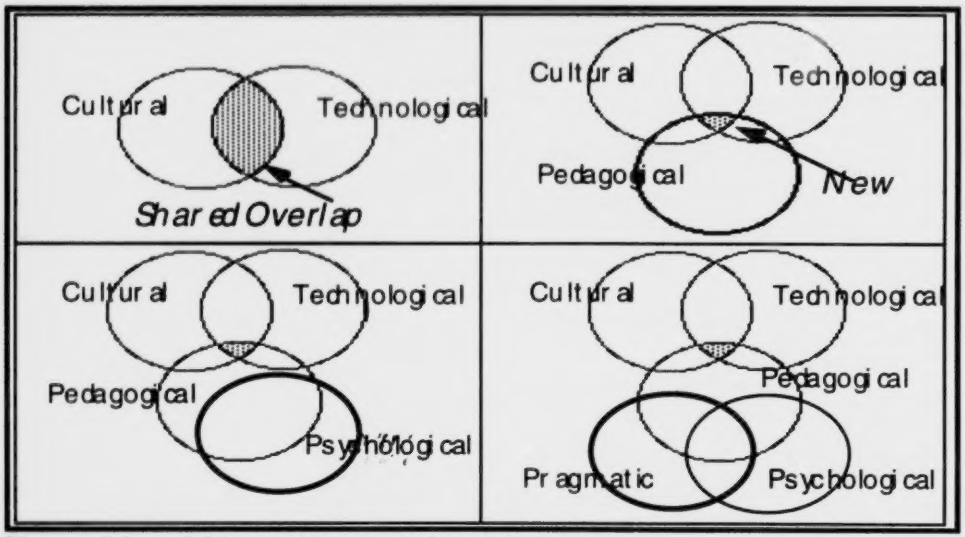

Psychological
Pedagogical
Cultural
Technological
Pragmatic

Figure 1: An integrated environment


Cultural
Technological
Shared Overlap
Cultural
Technological
Pedagogical
New
Cultural
Technological
Pedagogical
Psychological
Cultural
Technological
Pedagogical
Pragmatic
Psychological

Figures 2.2a - 2.2d: A disconnected environment

The underlying assumptions determine how (or if) the information within each of the foundations will be connected in a learning environment. This is true regardless of specific biases and perspectives. For instance, objectivists draw upon a subset of philosophies, methods, and technological activities that are uniquely appropriate to their underlying assumptions. Constructivists reference the same foundation pool, but derive distinctly different strategies based upon altered underlying assumptions. The underlying assumptions, then, dictate how the foundations will be operationalized in any environment. As the assumptions vary, the foundations, and hence the features and methods, of the learning environment change accordingly.

Assumptions of Student-Centered Learning Environments

Student-centered learning environments comprise many forms, often with few apparent similarities. Isolated student-centered environments in science, mathematics, social science, literature, and other domains have prompted educators to explore the structure, goals, and perspectives of student-centered systems. The efforts, however, often appear dissimilar in functions, goals, and features, thus making it difficult to identify general design principles. Despite such variations, common assumptions have been identified and are manifested either explicitly or implicitly within the environment (Hannafin et al., 1994).

Student-centered learning environments are rooted in several assumptions. These assumptions are based on a synthesis of empirical research, theory, and supporting examples-- primarily from areas such as situated cognition, microworld design, mental model development, metacognition, and process learning. These assumptions represent how the learner, knowledge, and structure of the environment are conceptualized. While a complete treatment of the differences is not possible here, several critical assumptions and accompanying functions of student-centered learning environments can be identified. Table 1 summarizes the assumptions with supporting functions.

Table 1: Assumptions and Functions of Student-Centered Learning Environments

Assumption	**Functions**
Instruction, as traditionally defined, is too narrow to support varied ways of promoting learning	• Allows learners to "make sense" out of what they know. • Supports meta-knowledge about problem solving. • Encourages deeper understanding and theory building.
Activities must focus on the underlying cognitive processes-- not solely products of learning	• Increases meaningful learning and connections among ideas. • Combats rote memory and disassociation of knowledge. • Supports learning of self-regulation and meta-knowledge.
Knowledge is dynamic and continuously evolving	• Supports learners in building upon intuitions or mental models. • Understanding is refined through experience and exploration. • Addresses compliance vs. evaluation of knowledge issue.
Individuals must assume a greater responsibility for their own learning	• Encourages unique sense making capabilities of learners. • Supports learning of self-regulation skills. • Supports active learning and individual construction of knowledge.
Learners perform best when varied/multiple representations are supported	• Conceptual diversity requires varied representations and activities. • The potential for complex understanding increases as the environment becomes rich and engaging. • Supports multiple perspectives and flexible understanding.
Learning is best when rooted in relevant contexts	• Orients learners to inter-relatedness of knowledge. • Learner uses knowledge as a "tool". • Cognitive process and context are inextricably tied.
Learning is most relevant when rooted in personal experience	• Thinking originates from personal experience. • Normally abstract notions can be experienced and manipulated. • Learners develop insights into the "why" behind experiences.

Table 1. (continued)

Assumption	Function
Reality is not absolute, but is a personal by-product of context, interpretation, and negotiation.	• Learners formulate and modify initial understanding. • Errors are useful as data for refining understanding. • Wisdom cannot be "told."
Understanding requires time	• Understanding must be cultivated and not described. • Understanding is deeper when learners "get to know" and explore it. • Understanding transcends the information given.
Understanding is best supported when processes are augmented, not supplanted, by technology.	• Allows novices to become familiar with complex notions without excessive cognitive load. • Engages learners in complex ideas/problems encountered by experts. • Leads to understanding that surpasses what could be achieved without support.
Learners make, or can be guided to make, effective choices	• Supports development of learner's "need to know" information. • Establishes an "anchor" upon which further information can be added • Learners see errors as a cue for further information in process of working towards a goal.

Conclusions

Advances in technology have enabled the development of a range of learning environments. These environments reflect diverging views about the nature of knowledge and understanding, the role of learners, and the manner in which learning environments should be structured. This paper has identified underlying assumptions and relevant foundations for a particular group of approaches--student-centered, computer-enhanced learning environments--that manifest similar features and attributes. Based upon the underlying beliefs of student-centered learning, the value of the environment can be optimized based upon foundations that are not only consistent with, but a direct manifestation of, the assumptions.

It is important to recognize that viable alternatives to traditional instructional methodologies exist, alternatives that are rooted in different assumptions and draw upon different research and theory bases than do traditional approaches. The shifts are fundamental, not cosmetic or semantic, in nature. The issue is not simply one of emphasizing similarities across approaches, but comprehending the differences in assumptions and foundations that underlie them. It is unlikely that renaming traditional processes, without altering basic beliefs about the processes themselves, will significantly alter the nature of the learning environment. Indeed, in many cases, traditional methods have been largely unsuccessful in promoting the kinds of critical thinking and problem-solving widely sought. If we aim to address sophisticated learning goals involving in-depth study, problem solving, and reasoning, alternative assumptions, foundations, and methods must be considered.

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Title:

Motivational Screen Design Guidelines for Effective Computer-Mediated Instruction

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Abstract

Screen designers for computer-mediated instruction (CMI) products must consider the motivational appeal of their designs. Although learners may be motivated to use CMI programs initially because of their novelty, this effect wears off and the instruction must stand on its own. We surveyed approximately 92 articles and books to compile screen design guidelines that were proposed by their authors in whole or in part on the basis of their contribution to motivational appeal. Two primary types of guidelines were discovered-those aimed at enhancing motivation and those aimed at preventing loss of motivation. The authors call the first type of guideline "expansive," and the second "restrictive." The authors propose a framework that designers can use to apply the two types of guidelines and arrive at effective screen design.

INTRODUCTION

Computer-mediated instruction (CMI) systems are increasingly used for learning and training in school as well as in corporate settings. Designers of CMI aim to design presentations that will encourage and facilitate learning. Screen design, as the communication vehicle for most of the human-computer interface, refers to "the purposeful organization of presentation stimuli in order to influence how students process information"(Hannafin & Hooper, 1989, p. 156). Studies on human memory and message design consistently show that well organized material causes learners to develop and maintain interest in lesson content, promotes the learner engagement with the material, and facilitates deep processing of important information better than does unorganized material (Cook & Kazlauskas, 1993; Faiola & DeBloois, 1988; Grabinger & Albers, 1989; Hannafin & Hooper, 1989). Well organized material also improves reading speed and comprehension, and effectiveness and efficiency of learning from CMI (Galitz, 1989; Hannafin & Hooper, 1989; Hathaway, 1984; Strickland & Poe, 1989).

CMI delivers information in a variety of ways including text, graphical images, color, animation and audio, and other components of screen. Well designed CMI screens combine these elements into a whole, cohesive and balanced display (Moore & Dwyer, 1994). Skillfully designed CMI screens should not only provide the content and functionality to satisfy learner's needs in a manner that draws learners' attention, motivates interaction, and helps them accomplish learning goals without confusion and fatigue (Faiola, 1990; Galitz, 1989; Jacques, Preece, & Carey, 1995; Shneiderman, 1992), but also contribute to quality and usability (Tufte, 1992).

Motivation is a frequently used word in the literature of education and computers, however, the study of motivation has long been a neglected area in instructional technology (Rezabeck, 1994). To be effective, instruction must be appealing to learners. Many learners do find CMI programs novel and appealing, at least initially. Most CMI programs often contain interactive communication, automatic feedback, animated graphics, sound effects, and freedom to make mistakes without fear of censure. If CMI screens are not well designed, or lack motivational appeal beyond the novelty level, then learner involvement wanes, and the program is abandoned (Keller & Suzuki, 1988). Consequently, it is critical for designers of CMI to make screens that are appealing at a level beyond the novelty effect in addition to making the screens instructionally efficient and effective.

Keller (1983) suggests that motivation attracts learners to the instruction and increases their effort in relation to the subject . Bohlin and Milheim (1994) concur, stating that motivation provides appeal or interest for the learner and stimulate learner effort. With reasonable limits, the greater the motivation, the greater will be the learning (Butler, 1972). According to Keller's ARCS model (Keller, 1987), instructional motivation has four main components: it should gain and sustain attention of learners (attention), pertain to the needs and familiarity of learners (relevance), foster confidence in accomplishing the learning task (confidence), and satisfy learners by meeting their expectation (satisfaction).

Screen design for effective CMI is not complete without considering its motivational appeal. Most designers would agree with these assertions, however, many would think of motivation for CMI as a consideration to be brought up late in the design process (Keller & Burkman, 1993). Motivation should be considered throughout the design and development process (Okey & Santiago, 1991; Keller & Kopp, 1987). Many designers believe that effective use of motivational elements for CMI screens can contribute to increasing motivation to learn. Keller and Burkman (1993) go so far as to suggest that the motivation to learn is, in large part, a CMI designer's responsibility, not learner's responsibility.

Motivational screen design should be related to orienting learners toward the instruction, encouraging deep processing, focusing attention, engaging learners on task, and resulting in better performance (Grabowski & Curtis, 1991; Mukherjee & Edmonds, 1994). CMI texts with a high legibility enable the readers to devote their attention to understanding whatever information the text conveys. Inherently rewarding interactions increase learner's intrinsic motivation to continue, which can lead to a state of flow: a condition in which "people are so involved in an activity that noting else seems to matter" (Csikszentmihalyi, 1992, p. 4).

The purpose of this article is to identify the available guidelines for effective, user-friendly designed CMI software to maximize learners' performance of the content material and their motivation to learn, and place these guidelines in a useful framework for making CMI system more effective, efficient, and appealing.

GUIDELINES FOR MOTIVATIONAL SCREEN DESIGN

The authors discovered two primary types of guidelines in the books and articles surveyed. The first type is aimed at supporting intrinsic motivation or enhancing extrinsic motivation. The second type is aimed at preventing the loss or degradation of either intrinsic or extrinsic motivation. We call the first type of guideline "expansive," and the second type "restrictive."

There are many components of screen design which may affect the motivational value of CMI screens, however, this present study will be focused on five screen design elements: typography, graphical images, color, animation and audio. Guidelines for each category are listed based on the expansive and restrictive classifications.

Typography

First of all, typography is the key element in text materials and in almost any well-designed table, chart, map, or diagram (Marcus, 1992). Generally, text on screens has been found to be less legible than text on paper. Text display on computer screen can be difficult to read or easy to read, depending upon the font, the screen layout, and the contrast provided (Moore & Dwyer, 1994).

Signals are writing devices that emphasize aspects of a text's content or structure without adding to the content of the text and help readers identify specific points in a text (Golding & Fowler, 1992; Lorch, 1989). These include titles, headings, pre- and post- instructional strategies, such as preview, overview and summary, and typographical cues (Golding & Fowler, 1992; Lorch, 1989). Although there are many typographical motivation elements for CMI system, they are all share the goal of directing the learner's attention during learning. Signals including typographical cueing may lead to enhanced memory performance as the result of a von Restorff effect[12]. The result is that the isolated events have a higher probability of being recalled at a later time (Glynn, 1978). Signaling is information in text that does not add new content on a topic, but that gives emphasis to certain aspects of the semantic content or points out aspects of the structure of the content (Meyer, 1985). Signaling should serve to clarify content.

Typographical cueing system, defined as the attachment of a specific meaning to a part of a text by displaying it in a way which is different from the rest of the text, controls mathemagenic behaviors. Typographic coding in CMI screen is mainly used for accentuating; the accentuation can relate to single words, phrases or whole paragraphs (van Nes, 1986). The cueing systems guide the construction and implementation of learner's prose-processing decision criteria (Glynn & Di Vesta, 1979). However, we should try to establish a hierarchy of importance using the techniques above and then employ it consistently throughout the CMI system.

Expansive Guidelines

- Use graphic character fonts for attention-catching because of their size and unusual shape, even if less legible than normal fonts (van Nes, 1986).

Restrictive Guidelines

- Be consistent in assigning textual cues and messages to the learner (Faiola, 1990). Consistency in typographic attributes can establish and convey a very clear visual message to the viewer that (s)he is now reading a certain subject or section of instructional content.
- Use both upper and lower case letters (Apple Computer Inc., 1989; Faiola & DeBloois, 1988). The legibility of text with letters in mixed case, i.e. with capitals only used for indicating the first letter of a sentence, a name etc., is higher than in upper case only (van Nes, 1986). All upper case characters should be used only occasionally, and for the purposes of emphasis (Strauss, 1991).

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[12] von Restorff effect refers to "signaled information is remembered better because it is perceptually salient or isolated from the rest of the text." (Golding & Fowler, 1992, p. 100)

- Use high contrast between letters and background to improve legibility and readability (Isaacs, 1987; Pastoor, 1990; Reynolds, 1979; Revlin, Lewis, & Davies-Cooper, 1990).
- Left-justify text, but do not right-justify it (Garner, 1990). Limit text to approximately 65 character per line, or a maximum of 8-10 words per line (Galitz, 1989; Garner, 1990). Increase the spacing between lines for long lines of text (Garner, 1990; Hartley, 1990).
- Use highlighting techniques conservatively and carefully, since they are likely to attract the reader's attention (Apple Computer Inc., 1989; Galitz, 1989; Hartley, 1987; Heines, 1984; Isaacs, 1987; Rivlin, Lewis, & Davies-Copper, 1990). Underlining and blinking should only be used if they do not interfere with the legibility of the text (Heines, 1984; Merrill, 1988; Rivlin, Lewis, & Davies-Cooper, 1990; Tullis, 1988). Flashing should be reserved for items that must convey an urgent need for attention. Reverse video can be an effective method in attracting the reader's attention, but it should be used judiciously to avoid the "crossword-puzzle effects" (Galitz, 1989, p. 61).
- Select a typeface with a simple, clean style and use a few typefaces in any one screen or CMI program (Apple Computer, Inc., 1989; Hartley, 1994). Most screens look best with no more than two different fonts, using different sizes and weights of each (Strauss, 1991).

Graphical Images

With the advent of the first widely used graphical user interface(GUI) computer by Apple Computer in 1984, it became possible to do more sophisticated things with the CMI screen design (Jones, 1995). Graphical images including pictures, graphics and illustrations throughout CMI system can function to attract and maintain attention, and facilitate learning from text materials (Duchastel, 1978; Levie & Lentz, 1982; Rieber, 1994). Graphical images can also provide functional guidance, aesthetics charm, and corporate or product identity (Marcus, 1992).

Even though using graphical images to arouse general curiosity and interest in CMI system seems as a very superficial way, they offer the potential to increase the challenge and curiosity of the task, as well as encouraging students to be creative and use their imaginations (Rieber, 1994). Learning certainly demands effort and hard work, but instruction does not need to be boring and dull. So we need deeper ways to maintain attention and interest beyond the simple provision of interesting graphical images. Screen designers attempt to achieve visual solutions using graphical elements that are functional, elegant, appropriate, simple and economical, and consistent (Hartley, 1987). The use of graphical images may enrich presentations and make them more attractive to the learners.

Expansive Guidelines

- Consider the overall standard of imagery that meet learner expectations for style (Rivlin, Lewis, Davies-Cooper, 1990).

Restrictive Guidelines

- Use simple and clear images to make CMI more effective (Levie & Lentz, 1982; Marcus, 1992; Rivlin, Lewis, & Davies-Cooper, 1990; Tompson, 1994). Don't use images with too much detail at a small scale as this can be lost on screen. Simple image are more effective for instruction than complex images.
- Use graphical images for instructional, motivational, or attention-focusing effects, and not simply for the sake of including them on the screen (Duchastel, 1978, 1983; Levie & Lentz, 1982; Pettersson, 1993; Rieber, 1994; Surber & Leeder, 1988).
- Make sure all the key components of the graphical images are labeled (Rivlin, Lewis, & Davies-Cooper, 1990). Use captions or title for labeling the key elements of graphical images.
- Consider the prior knowledge and cultural conventions of the learner in choosing graphical image components (Apple Computer Inc., 1989; Boling, Johnson, & Kirkley, 1994, Easterby, 1970). Avoid sexist, culturally-sensitive, and other potentially offensive imagery. However, include pictures of people, plants, and animal with relatively large and detail for especially appealing to girls, while include vehicles or machines in action for only appealing to boys (Jakobsdóttir, Krey, & Sales, 1994).
- Obey any existing conventions, such as the standard symbols in a circuit diagram or the top to bottom or left to right order for a low chart (Rivlin, Lewis, Davies-Cooper, 1990).

Color

Color can also be used effectively within CMI system for aesthetic and motivational reasons (Galitz, 1989; Hartley, 1987, 1994; Heines, 1984), however, it is the most sophisticated and complex of the visible language components for screen design. Color may promote deep processing of important information, aid in organizing lesson content, allow reasonable learner-control options, promote interaction between the learner and lesson content, and facilitate lesson navigation (Hannafin & Hooper, 1989). Most researchers seem to agree that colored images are desirable from a motivational point of view, although the research suggests that the motivation effect of graphical images varies greatly with the age, the intelligence and the education of the reader (Hartley, 1994). While claims are often made for the motivational value of color in instructional materials, the research findings on motivation are by themselves not strong enough arguments for using color (Brockmann, 1991; Misanchuk & Schwier, 1995).

However, misuse and misunderstanding of the use of color is common. The differently colored part will involuntarily attract fixation of the eye when it scans the page. A part of a text may rapidly found by giving it a specific color, provided the learner knows which color to look for. Color differences, therefore, can deliberately be used as efficient search aids (van Nes, 1986).

Expansive Guidelines

- Make color coding aesthetically pleasing and logically toward lesson objective (Chapman, 1993). Use a bright color to cue the learner for new information, while presenting the reminder of the information in standard colors consistent with the rest of the screen (Knupfer, 1995).

Restrictive Guidelines

- Use color in the conservative way: limit the number and amount of colors used (Brockmann, 1991; Davidoff, 1987; Garner, 1990; Shneiderman, 1992; Strauss, 1991). Use a maximum of five plus or minus two colors per screen (Faiola, 1990; Marcus, 1992; van Nes, 1986).
- Use colors selectively to manipulate attention. Color can be used to highlight text or graphics to make them conspicuous (Durrett & Trezona, 1992; Garner, 1990; van Nes, 1986).
- Keep consistency in color coding (Faiola, 1990; Galitz, 1989; Marcus, 1992). Consistency is crucial for CMI screen design. Carefully select colors for all visual devices such as touch screens, buttons, menus, and titles, and never change the coding scheme during the presentation (Brockmann, 1991; Chapman, 1993; Faiola, 1990; Faiola & DeBloois, 1988; Galitz, 1989; Heines, 1984; Marcus, 1992; Milheim & Lavix, 1992; Shneiderman, 1992; Rivlin, Lewis, & Davies-Copper, 1990; Strauss, 1991).
- Use cool, dark, low-saturation colors (e.g. olive green, gray, blue, brown, dark purple, black, etc.) for background that recede and do not vie for the user's attention, while foreground colors can be hotter, lighter, and more highly-saturated colors (lemon yellow, pink, orange, red, etc.) that tend to come forward on the screen and attract the user's eye (Faiola, 1990; Faiola & DeBloois, 1988; Milheim & Lavix, 1992; Strauss, 1991; Tufte, 1992; van Nes, 1986).
- Avoid the use of complementary colors (e.g. blue/orange, red/green, violet/yellow) (Heines, 1984).
- Use commonly accepted colors for particular actions, remembering that such color may be appropriate only for specific culture or social systems (Shneiderman, 1992). Colors should match conventional meaning and symbolic associations (Chapman, 1993; Loosmore, 1994).
- Use higher levels of brightness for distinguishing colors according to learners age (Misanchuk & Schwier, 1995).

Animation/Audio

Animation can be an effective way of arousing and maintaining a learner's attention during CMI system. The purpose of the animation sometimes is not to teach something, but only to attract and focus the learner's attention onto the CMI screen (Rieber, 1990, 1994). Animation should be incorporated only when its attributes are congruent to the learning task (Rieber, 1990). Screen designers should not be over-ambitious with animation. Moving a small component on the screen is often more effective and generally easier to achieve (Rivlin, Lewis, & Davies-Cooper, 1990).

Although animation can be a very dramatic visual effect, the efficacy of animated presentations on cognition is quite subtle (Rieber, 1990). Animation, like any graphical images, would also be expected to help learners to visualize a dynamic process that is difficult or impossible for them to visualize on their own, and would facilitate learning tasks

(Rieber, 1990). The mental processes of selection and organization are particularly important considerations in designing animated displays because of the temporal nature of these displays.

Audio in CMI program is not a new phenomenon, however, little research has been done. In language and speech training audio was also a common feature (Aarntzen, 1993). Audio can draw and hold learners' attention to the most important parts of the CMI screen, complement the visual information on the screen, support the learner reading the text on the screen (Aarntzen, 1993). Generally, there are three kinds of audio sources: (a) voice or speech, (b) music, and (c) sound or natural effects (Brewer, 1986).

The function of sound is temporal when spoken instructions and directions are provided about a future event, or feedback about the past, creating a synergistic relationship with the visual presentation (Mann, 1995). Temporal sound may help to focus learner's attention on critical information from the CMI program, particularly when they can listen to the highlights as well as read the details, however, Barron and Kysilka (1993) report that digital audio did not have a significant effect on overall comprehension of the tutorial content.

Expansive Guidelines

- Use graphical animation to explicitly represent highly abstract and dynamic concepts in science, including time-dependent processes (Park, 1994; Park & Hopkins, 1993; Reiber, 1990, 1994).
- Use animation as a substitute or aid for verbal communication (Park, 1994; Park & Hopkins, 1993).

Restrictive Guidelines

- Use animation sparingly and only when required to enhance CMI program (Rieber, 1990; Venezky & Osin, 1991). Small and simple animation may be more effective than large ones (Rivlin, Lewis, & Davies-Cooper, 1990).
- Use congruent animation to the learning task (Reiber, 1990, 1994). Use animation as a visual analogy or cognitive anchor for the instruction of problem solving (Park, 1994; Park & Hopkins, 1993). Use animation to simulate functional behaviors of mechanical or electronic systems and to demonstrate troubleshooting procedures (Park, 1994; Park & Hopkins, 1993).
- Avoid unnecessary or gratuitous animation on the screen not to distract (Strauss, 1991). Do not harm using unnecessary animation. The simpler animation, the better result.
- Use voices or speech for providing information. When speech is used as the mainstream provider of information, same text should appear on the screen. According to redundancy theories (Aarntzen, 1993), this will enhance learning.
- Use calm music to create a relaxing atmosphere; Use loud sound for alarm and warning messages (Aarntzen, 1993).

INTEGRATIVE GUIDELINES FOR MOTIVATIONAL SCREEN

Based upon the results of exploring the motivational screen design guidelines, the issues in CMI screen design are not which fonts are inherently best, whether to double space routinely, or whether to employ color or sound, but how to best to utilize those elements to promote appropriate learning processing (Hannafin & Hooper, 1989). Each of motivational screen elements is not effective definite roles to play in instructional media. The instructional roles of each element and the instructional conditions appropriate for their use are an attempt to move us closer to a realization of the effects on integrated design factors.

The task of the instructional designer who wants to make instruction both effective and appealing is to link the ideas of motivational design to an instructional design theory (Main, 1993; Okey & Santiago, 1991). Motivational screen design supports instructional strategy. Instructional strategy should be sound in view of content selection and sequencing appropriate for audience and learning goals (Reigeluth, 1983). If these conditions are not met, motivational screen design can't fix the problems such as engaging learners in irrelevant instruction or demotivating learners further than usual. Instructional design and motivational design are complementary, not conflicting ideas.

Integration of Motivational Elements

According to dual-coding model on perception and cognition (Paivio, 1978, 1983; Bleasdale, 1983), coding an item in two ways will enhance memory more than coding an item in one way only. Researches on cueing (Grabinger, 1989; Grabinger & Albers, 1989) have shown that learners learn best when they are cued to specific information in an application. The cue summation theory has also been the focus of much research into multichannel communication.

This principle of learning theory predicts that learning increases as the number of available cues or stimuli is increased (Barron & Kysilka, 1993). Designers of CMI should consider the question of how the combination of visual and auditive screen design elements should be for motivating learners (Aarntzen, 1993).

Some of the more substantial guidelines for the CMI screen emerge from the tradition of print-based materials (Hartley, 1994; Tinker, 1964, 1965). Guidelines generalized from researches related to screen design offer specific recommendations as to individual elements of the CMI screen design such as typography, graphical images, color, animation/audio, and so forth. Although single element research, as a necessary first step in understanding how to combine elements into overall screen, is extremely important in identifying the strengths, weaknesses, and potential problems of using specific attributes on CMI screen, they often do not address the overall visual dimension of the CMI screen (Grabinger, 1989; Haag & Snetsigner, 1994).

Motivational screen design elements should be integrative and holistic perspective as the effect of multimedia is more than just the sum of its individual elements (McKerlie & Preece, 1993). The combination of these elements to create an overall design, look, or aesthetic is one not typically addressed in the current literature (Hagg & Snetsigner, 1994). Multi-elements research, as "visual gestalt of a screen" (Grabinger, 1989, p. 179), tends to be more complex than single-element research on motivational screen design for effective CMI program.

Motivation and achievement interact in ways that warrant a "holistic" examination of strategies incorporated into CMI program. It should serve to captivate the learner's attention, promote feelings and expectations of success, improve perception of control, increase positive attributions to effort and ability, and enhance self-efficacy and foster achievement and positive affect through social interaction (Relan, 1992). Motivating students to learn and become life-long learners is an especially important and difficult task for a teacher (Bohlin, Milheim, & Viechnicki, 1993). CMI is often very motivating to students, especially when the lessons involve animated characters, voice capabilities, and full-color graphics (Blickhan, 1992). The use of both visual and audio to arouse the learners' attention is more likely to increase interest than the use of visual or sound alone (Frence & Vockell, 1994). Motivation is a key factor in all types of learning.

Overall Motivational Guidelines

- *Use* the motivational elements of CMI screen as *economically* as possible (parsimony principle). The economic use of motivational CMI screen elements should be made of screen display elements to get the designer's message across as simply and clearly as possible (Galitz, 1989; Garner, 1990; Heines, 1984; Rivlin, Lewis, & Davies-Copper, 1990, Schwier & Misanchuk, 1993; Shneiderman, 1992). A well design screen should "...exhibit no annoying or distracting features" (Strickland & Poe, 1989, p. 89). The implication is that screen elements over and above the minimum required will be experienced as annoying or distracting.
- *Keep* the CMI screen *consistent* in using the motivational elements of CMI screen (consistency principle). Consistency in cueing should be applied to all usages of fonts, sizes, spacing, color, and any other attribute. Visually pleasing arrangements focus the perception of structure (Faiola, 1990; Garner, 1990). Consistency is critical for CMI screen design. Consistency states that the appearance, location, and behavior of motivational elements should remain constant, and that screen elements with similar function should share similar appearance, location, and behavior (Faiola, 1990; Galitz, 1989; Lucas, 1991; Marcus, 1992; Shneiderman, 1992). Consistency also makes a CMI program easy to learn, use, and remember (Shires & Olszak, 1992), and reduces the effort required to learn new programs (Apple Computer Inc., 1992, Galitz, 1989).
- *Make* the CMI screen *aesthetically* (aesthetics principle). It states that general rules of visual composition (balance, symmetry, unity, and harmony) should be regarded in CMI screen design (Galitz, 1989; Garner, 1990; Misanchuk, 1992; Reilly & Roach, 1986; Strauss, 1991; Thompson, 1994). Aesthetically pleasing CMI can attract and hold the learner's attention more successfully, and will promote cognitive learning better than, CMI screens constructed without regard for aesthetics (Hagg & Snetsigner, 1994; Lucas, 1991; Misanchuk, 1992; Pett, 1989; Reilly & Roach, 1986; Schwier & Misanchuk, 1993; Thompson, 1994). Well-designed CMI screen can be creative and aesthetically pleasing (Misanchuk & Schwier, 1995).

Based upon the literature review, it can be proposed a framework that can use to apply the two types of guidelines and arrive at effective screen design. Following is the summary of the framework. (Table 1)

Table 1
Framework for Motivation in the Screen Design Process

Type of design in the development process	**Learner activities requiring motivation**	**Screen design issues most relevant to learner activities**	**Engagement goals** (Jacques, Preece & Carey, 1995)
instructional design	apply judge consider reflect	look and feel metaphor production value	encourage
function design	explore attend comply	interaction sequencing art direction	facilitate
form design	navigate click/type see and hear	layout text graphical images audio	don't distract

In considering motivation as it relates to screen design for CMI, it may be useful to note that the learners' motivation in the experience is not only important at the highest level, which is in relation to the learning. The learner needs motivation for different types of activities within the CMI experience: to click a "Forward" button, to explore more then one path in a hypertext environment, or to compare two video sequences at the content level in order to draw a conclusion about some subject. Only one of these activities represents what might be called a "learning activity," although the others must be recognized as contributors, and perhaps prerequisites, for learning to occur. Column 2 of Table 1 shows examples of the types of activities learners may carry out during the CMI experience, and it breaks those activities into three groups according to the relative complexity of carrying them out.

For the sake of this discussion, instructional design is presumed to mean the selection of strategies and tactics for delivering the CMI experience. Functional design is the description of the capabilities that a CMI program will have, and the capabilities it will place under control of the program user, or learner. Forms design is the creation or selection of specific representations of function. By way of a simplistic example, the instructional design might specify that content will be delivered in an exploratory environment. The corresponding functional design might specify that "learners will be able to collect items of information and compare them as they move through the environment." These functions would be operationalized as forms - perhaps an illustrated knapsack into which the learner might drag items using a cursor in the shape of a tiny hand.

Screen design issues exist within the instructional design, function design, and forms design processes, although most guidelines and discussions purporting to relate to screen design are typically restricted to the forms design level. For any given element in the overall screen design, Column 3 of Table 1 lists examples of the types of issues for which a screen designer is responsible, and divides them into categories corresponding to the learners' activities.

The authors feel that once the distinctions we have drawn between levels of screen design issues are clear, it may be possible to characterize the overarching principle guiding each level of design activity according to the three primary goals of engagement laid out by Jacques, Preece, and Carey (1995) in their recent discussion of engagement as a design concept for multimedia. Although the design of an individual on-screen navigation button might aim to encourage learners by using animation to attract their attention and audio to entice them into choosing the button, it is our opinion that any "encouraging" features of a navigation button should be subordinated to the "don't distract" principle. At the top of the chart, however, a screen designer may wish to be cautious regarding the possible distractions inherent in a chosen metaphor, but that designer should err on the side of "encouragement" when looking for guidance at this level of the design.

Our survey of design guidelines reveals that most guidelines fall into what we have called the "restrictive" category, and further that most of them address only the bottom two rows shown in Table 1, with the majority addressing the lowest level only. We speculate that this may account for an overall "restrictive" view of screen design in the field, and that this view may keep instructional designers from discovering the strategies used by graphic designers, multimedia designers, and others in related disciplines to enhance the motivational aspects of screen design.

CONCLUDING REMARKS

Based upon the increasing use of CMI program for both education and corporate training, screen design is becoming an issue of great importance for instructional designers and developers in many different content areas. Instructional screen must provide effective and efficient instruction, appropriate navigation tools, and aesthetics. This article has sought to provide an integrated list of motivational screen design guidelines for effective CMI systems. It is hoped that these guidelines will provide a useful framework for making CMI system more effective, efficient, and appealing. Implications for motivational screen design will also help instructional developers for practical use. Without better understanding of motivational screen design guidelines, efforts for designing CMI system will continue largely by trial-and-error. In short, CMI designer should focus on motivational screen design that make the learning more appealing and the learner more confident.

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Title:

Criteria for Evaluating and Selecting Multimedia Software for Instruction

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Abstract

Evaluating and selecting the appropriate software is a very important component of success for using multimedia systems in both educational and corporate settings. This paper attempts to explore the issues surrounding the evaluation of multimedia software and to present a comprehensive criteria for evaluating and selecting multimedia software for effective instruction, from general software evaluation criteria to the specialized multimedia evaluation criteria. An integrated checklist for multimedia software evaluation was included. (*Key Words*: Computer-Mediated Multimedia (CMM), Software, Criteria Selection, Evaluation, Instruction)

INTRODUCTION

The use of microcomputers for education and training in schools and homes as well as in corporate settings are commonplace since relatively inexpensive microcomputers came on the market as an instructional tool. Many educational professionals believe that in the world of computers, media, and digital technologies, multimedia would play a large part in educational reform (Galbreath, 1992; Jost & Schneberger, 1994), and the software available for computer-mediated multimedia (CMM)[13] has been increasing both in quantity and in quality over the past couple of years.

Few instructional software programs, however, are field tested with actual students prior to distribution (Dudley-Marling & Owston, 1987; Heller, 1991). The ways in which these software are used vary with the context of their use, with different age levels, subject areas or classroom setting. Observers of instructional software have cited a number of specific problems with courseware, including technical inadequacy, poor pedagogy, amateurish programming, and inadequate documentation (Heller, 1991).

CMM system is an entirely new kind of media experience born from TV and computer technologies. It can be defined as the integration of two or more communication media, controlled or manipulated by the user via a computer, to present information (Cotton & Oliver, 1993; Holsinger, 1994; Galbreath, 1992; Poncelet & Proctor, 1993; Tolhurst, 1995). CMM program is a powerful combination of text, images, animation, sound, color, and video in a single, computer-controlled presentation. CMM entails "the use of the computer to integrate and control electronic media devices such as monitors, videodisc players, CD-ROM players, and other electronic equipment" (Poncelet & Proctor, 1993, p. 93), and offers random access. Evaluation and Selection of CMM systems, therefore, may be different from computer-mediated instruction (CMI).

Instructors, as well as parents, often have difficulty distinguishing quality instructional software from the trivial and ineffective software now on the market. Guidelines and sources of knowledge about evaluating and selecting quality software program are limited (Chang & Osguthorpe, 1987). As more of the instructional software is placed on the market, the need for careful review of the material prior to its purchase becomes increasingly necessary. CMM software, like all other educational material, should be evaluated with a thorough and detailed evaluation before it is used in the classroom (Heller, 1991).

According to the report of Educational Products Information Exchange (EPIE) (Taylor, 1987), only about a quarter of available software for elementary and secondary schools have been evaluated adequately. Neill and Neill (1993) also report that only 7.7% of the total reviewed software as 'worth of an A grade' using their criteria for quality assurance. This means that the end-users of computer softwares would have to conduct its own evaluation of three-quarters of the instructional software program it is considering. There appears to be a continuing need, therefore, for an approach to evaluating software which is general enough to be widely applicable but specific enough to provide the kind for information that will allow decisions to be made about the acceptability of software programs under reasonable consideration.

The purpose of this paper is to explore the issues surrounding the evaluation of multimedia software and to present a comprehensive criteria for evaluating and selecting CMM software for effective instruction, from general software evaluation criteria to the specialized multimedia evaluation criteria.

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[13] Computer mediated multimedia systems incorpoate "the computer as a display device, management tool, and/or source of text, pictures, graphics, and sound" (Heinich, Molenda, Russell, & Smaldino, 1996, p. 260).

EVALUATION AND SELECTION CRITERIA

Evaluation assumes a value judgment. When evaluating and selecting an instructional software, there are some general principles that apply to all categories of software. Almost every product-oriented evaluation includes some items about the use of the program. These aspects considered for evaluating instructional software might include such things as contents, curriculum issues, design factors, technology factors, human factors, documentation and packaging, availability of support materials, classroom management, vendor factors, cost factors, and so on (Gray, 1991; Gros & Spector, 1994; Heller, 1991; Knight, 1992; Reiser & Dick, 1990; Tolhurst, 1992).

Even though most of these checklist items were created for evaluating traditional CMI, similar proposals have been made for the evaluation of CMM software (Atkins, 1993; Gros & Spector, 1994; Hutchings et al., 1992; Knight, 1992). CMM software is quite different from traditional CMI in terms of linking display tools, management tool, and/or design elements such as text, graphical images, animation and sound. For this reason, new items of evaluation should be added. Nielsen (1990) proposed five additional parameters for evaluating the usability of multimedia software: ease of initial learning, efficiency of use, ease of remembering interface items, error rates, and subject response to the system.

Well designed CMM software is instructionally sound materials that take advantage of the unique capabilities of the computer. Unfortunately, however, not all programs marketed as CMM are well-designed, instructionally sound, and technically reliable (Sloane, Gordon, Gunn, & Mickelsen, 1989). To make a reasonable decision, criteria should be developed to give the evaluator a framework for the task. The most important criterion for CMM software evaluation is the consideration which reflects the needs and characteristics of individual teachers and students in using the CMM software.

Teachers can use a formal evaluation of CMM software to guide their initial screening of software, but their final judgment should depend upon their own observations of their students as the students interact with the software (Dudley-Marling & Owston, 1987). There is no one best CMM software-different software works best for different learners and for different instructional purposes, and no one CMM product is ideal for any location that serves diverse learners (Sorge, Campell, & Russell, 1993). Criteria considered for evaluating CMM software in the study include content issues, instructional design, user interface, and documentation. Evaluation criteria include address both general CMI evaluation criteria and the specialized CMM evaluation criteria.

Content Criteria

The content presented in CMM software should be appropriate to the its objectives and reflect the level of difficulty, sequencing and quantity of content sufficient to meet those objectives. Because objectives are used to plan instruction, to facilitate the evaluation of course outcomes, and to prepare and review test items (Taylor, 1987). Objectives may affect certain learner characteristics. The target audience, therefore, should be specified, grade level and particular characteristics such as gifted, talented, or handicapped (Gold, 1984). The learning objectives should be delineated, including how the various features of the instructional design fulfill the learning objectives, and should be stated in measurable terms so that the evaluation of lesson will reveal whether the mastery has been achieved.

The contents and instructions of CMM software should be accurate, fair, and valued. The presentation of CMM system content should not only be clear and logical, but be sufficiently simple, complex, technical or non-technical for the intended target learners (Bitter & Camuse, 1984; Gold, 1984).

General Criteria

- Instructional objectives are clearly stated.
- Definitions of target audience and prerequisite skills are stated.
- Contents and vocabulary level for intended users are appropriate.
- Specific information presented is accurate and answers are correct.
- Sequence of lesson information and instructions are logical and clear.
- Contents of cultural, sexual, and other stereotypes are free.

Specialized Multimedia Criteria

- Contents of text, image, animation, sound, video, etc. are congruent to CMM information.
- Terms or words in the CMM software are chosen appropriate for linking multimedia design elements (Tolhurst, 1992).

Instructional Design Criteria

Interaction activities in educational setting not only maintain learners' attention and increase their involvement on learning task, but also result in better performance on knowledge and/or skills. One of the essential features of CMM software in contrast to some other instructional media is its capacity to require and act upon learners' interaction. Researchers emphasize this important aspect of CMI, however, many commercial CMI software fall short in the characteristics (Alessi & Trollip, 1991). Designing interactions which are frequent, relevant, and increase learning is harder than even experienced CMM developers believe. Software evaluator should consider learner involvement as an important for evaluating CMM software.

Another advantage of CMM is its capability to individualize students' learning. The ability of instructional programs to adapt to individual needs rests upon the type of individual diagnosis they are capable of doing. Adaptive instruction must be capable of: (a) gathering diagnosis information; (b) inferring from this information the specific needs of the students, and (c) adjusting instruction accordingly (Venezky & Osin, 1991). Good CMM software will adapt to the learner, capitalizing upon his/her talents, giving extra help where the learners is weak, and providing motivators each learner responds to. However, most commercial software works about the same for all learners. Matching learners up with appropriate lessons and methodologies is important design factor of CMM software.

Motivation is an essential factor of instruction and learning. Instructional designers, therefore, should use appropriate motivational strategies for age level, and social and/or cultural background of the learner. Several motivation researches on CMI support that CMM techniques enhance learners' motivation and result in better learning. For the design of CMM programs, designers should first judge the degree of intrinsic motivation a course might tap in the target audience, and then decide how much, if any, extrinsic motivation is needed. The options for extrinsic motivators usually include game formats, humor, use of personal name for variation in drill formats and feedback on progress (Venezky & Osin, 1991).

Feedback is the reaction of a CMM software to the learners' response and may take many forms, including text message and graphic illustration. Its primary function is to inform the learner of the appropriateness of a response. There are two kinds of feedbacks: informative and motivational feedback. Informative feedback enables the learner to take corrective actions regarding behavior deficits, while motivational feedback is to increase the likelihood that the learner will continue to emit the behavior. Thus, motivational feedback is a form of reinforcement and most CMI researches on feedback support the effectiveness of feedback on learning (Taylor, 1987). To be a good CMM software, it can generate, store, and utilize appropriate feedback about learner needs.

General Criteria

- Learners are actively involved with interaction.
- Availability of varying levels of difficulty is provided according to the skill level of the learner.
- Motivational factors are included in CMM software.
- Appropriate feedback is provided.

Specialized Multimedia Criteria

- Learner can stop and move to different places in the CMM program without repetition.
- CMM software encourages a guided discovery or discovery mode of learning (Tolhurst, 1992).

User Interface Criteria

One of the claims about CMM software is that the user is free to explore paths through the combinational information such as text, graphics, sound, animation, video, etc. under computer control. The main concern of user interface criteria is always for an easy-to-use, easy-to-install, and easy-to-transport system (Knight, 1992). The evaluation of a piece of CMM software components can be guided by these inquiries topics: ease of use, clarity of directions and responses, simple error handling, screen design, learner control, and record keeping (Chang & Osguthorpe, 1987; DeJoy & Mills, 1989; Heller, 1991; Knight, 1992; Tolhurst, 1992).

CMM software installation should not require the service expert, but be able to be done on a hard disk. The steps should be clear and well defined. Tutorials should be included to aid the quick mastery of how the software works. One should be able to learn the basics in a short time. The CMM software needs to be branched in such a way as to allow sophisticated users to skip over the basic directions. After mastering the mechanics of using the CMM software, a learner will want to be able to streamline the commands. So frequent users can use shortcut such as abbreviations, special keys, hidden commands, macro facilities, and so on. Consistent sequences of actions should be required in similar situations and consistent commands should be employed throughout (Shneiderman, 1992).

Directions on how to operate the CMM software should be given in language appropriate to the target audience. Language, sentence length and complexity, and style of communication to the user should be clear and appropriate to the capabilities of the intended audience. The required reading level of the intended user must be respected (Gold, 1984).

Basically, there is lack of systems error in CMM software, however, learners occasionally hit the wrong key(s) by mistake. Even designing error-free system is best, it is very difficult job. If an error is made, it is hoped that nothing harmful, such as losing one's data, will occur. System should detect the error and offer simple, comprehensive mechanisms for handling the error (Shneiderman, 1992). The user should be signaled when a wrong key is hit. The learner can repair only the faulty part instead of retyping the entire command. Erroneous commands should leave the CMM system state unchanged, or the system should give instruction about restoring the state.

It is essential that the instructional information be formatted on the CMM screen for easy reading. Its display should keep clean, simple, attractive, and aesthetic balance using screen design elements such as text, image, animation, sound, color, video, etc. The use of visual cues can be effective in gaining and keeping the learners' attention during instruction (Faiola & DeBloois, 1988; Poncelet & Proctor, 1993). The use of screen design elements should be appropriate to CMM software and enhance the learning process and results.

Learner control is a crucial design variable in all CMI software. This means whether control of sequence, content, methodology, and other instructional factors is determined by the learners, the lesson, or some combination of two (Alessi & Trollip, 1991). In reality, all lessons have a mixture of learners and lesson control. The whole notion of interactivity is realized when course allows the learners to weave his/her own educational environment. This can be done by granting the learner control over certain aspects of the CMM software.

If CMM software is to utilize the full capabilities of computer effectively, it should have a sophisticated management systems. One of the most unique and useful capabilities of CMM software is its ability to keep track automatically of learner progress through software materials. If CMM software is equipped with this capacity, it will be much benefit for teachers (Truett & Gillespie, 1984). Good record keeping abilities should allow for the tracking of an entire class of learners, not merely the accounting of one learner's work.

General Criteria

- Management system of CMM software is easy to use and flexible.
- Screen displays are easy to read (text size/color/spacing).
- Screen design elements such as text, image, sound, animation and color combine to enhance, not distract from information presentation.
- CMM software allows the learner to correct his/her error. Error messages are helpful and user-friendly.
- Screen display should be kept clean, simple, attractive as well as aesthetically balanced. Special effects are used effectively and not overdone.
- Learners have control over the rate of presentation and/or navigation.
- A clear and useful summary of learners' activities and progress is provided.

Specialized Multimedia Criteria

- Multimedia element links and system links are distinguishable (Tolhurst, 1992).
- CMM software contains different contexts of use (e. g. descriptive text and a glossary).
- CMM software contains aids to assist learner navigation.

Documentation Criteria

Documentation is to help the user install and maintain the CMM software. The purpose of user's manual is to inform the learners of two things: the operation of the CMM software and the instruction on software design (Gold, 1984). User's manual should be included the following: (a) specifications of the hardware configuration, operating system and programming language code; (b) definition of any external software required; (c) installation instructions; (d) instructions on how to operate the software; and (e) explanation of how to exercise features.

The instruction on CMM software design should be written objectives, content, curriculum issues, and evaluation. The target audience should be specified as to age, grade level, any particular characteristics such as gifted or handicapped. For the knowledge issues, the knowledge and/or skill prerequisite for the CMM software must be clearly stated. For evaluation, the CMM software should provide the teacher and the student a way to evaluate learner performance and effectiveness (Gold, 1984).

It is imperative that CMM software be accompanied by a technical manual containing general information, functional description, and required features (Gold, 1984). The technical manual should include general information that describes the technical features, hardware configuration, operating system and programming language or code. It should also contain complete installation and start-up instructions. The manual should contain a functional description including an explanation of how each feature works, when it operates, under what conditions and any restrictions that apply to its use. It should explain in detail how to exercise each feature.

General Criteria

- User's manual contain detailed and complete indices of the information available in the CMM software.
- Commands for operation are consistent and thorough, including the use of multiple diskette or discs (DeJoy & Mills, 1989).
- Directions for installation and operation are clear, accurate and complete (Sorge, Campell, & Russell, 1993).
- Specifications of hardware requirements, operating system and programming language code are provided.
- Any requirements for staff support are made clear.
- An information 'hot line' is available.

Specialized Multimedia Criteria

- The linking maps or descriptions of the hypertext and/or other screen links are provided (Tolhurst, 1992).
- Any identification or description of the branching techniques used in CMM software is presented.

CONCLUDING REMARKS

The focus of this presentation is on discussing the issues surrounding the evaluation of CMM software and on building a comprehensive criteria for evaluating and selecting CMM software for effective instruction. These criteria will provide a useful framework to help educators and/or trainers select a quality instructional software for their instructional purposes. However, there is no widely agreed-upon standards or criteria for CMM software evaluation. It is a paramount need to develop not just minimal standards but standards that will act as guidelines to help developers, evaluators, and consumers determine what quality CMM softwares are.

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Appendix
Multimedia Evaluation Checklist

General Information Date:

Software Title:	Source/Distributor: Phone: Fax:
Subject Area:	Cost:
Target Audience:	Length:

Minimum Hardware Requirements

Computer Platform: ( ) Macintosh (II, IIe, IIgs) ( ) IBM ( ) Other

Memory: ( ) 1M ( ) 2M ( ) 3M ( ) 4M ( ) 5M ( ) 10 M ( ) Other ( ).

Requirements: ( ) Printer ( ) Mouse ( ) Color Monitor ( ) Videodisc ( ) Other

Content

Criteria	Rating*	Weight**
General • Instructional objectives are clearly stated. • Definitions of target audience and prerequisite skills are stated. • Contents and vocabulary level for intended users are appropriate. • Specific information presented is accurate and answers are correct. • Sequence of lesson information and instructions are logical and clear. • Contents of cultural, sexual, and other stereotypes are free. Multimedia • Contents of text, image, animation, sound, video, etc. are congruent to CMM information. Σ Terms or words in the software are chosen appropriately for linking multimedia design elements.		

Instructional Design Criteria

Criteria	Rating*	Weight**
General • Learners are actively involved with learner interaction. • Availability of varying levels of difficulty is provided according to the skill level of the learner. • Motivational factors are included in software. • Appropriate feedback is provided. Multimedia Σ Learner can stop and move to different places in the program without repetition. Σ Software encourages a guided discovery or discovery mode of learning.		

User Interface Criteria

Criteria	Rating*	Weight**
General • Management system of the software is easy to use and flexible. • Screen displays are easy to read (text size/color/spacing). • Screen design elements such as text, image, sound, animation and color combine to enhance, not distract from information presentation. • Software allows the learner to correct his/her error. Error messages are helpful and user-friendly. • Screen display should be kept clean, simple, attractive as well as aesthetically balanced. Special effects are used effectively and not overdone. • Learners have control over the rate of presentation and/or navigation. Σ A clear and useful summary of learners' activities and progress is provided. Multimedia • Multimedia element links and system links are distinguishable. Σ Software contains different contexts of use (e.g. descriptive text and a glossary). Σ Software contains aids to assist learner navigation.		

Document Criteria

Criteria	Rating*	Weight**
General • User's manual contain detailed and complete indices of the information available in the software. • Commands for operation are consistent and thorough, including the use of multiple diskette or discs. • Directions for installation and operation are clear, accurate and complete. • Specifications of hardware requirements, operating system and programming language code are provided. • Any requirements for staff support are made clear. • An information 'hotline' is available. Multimedia • The maps or descriptions of the hypertext and/or other screen links are provided. Σ Any identification or description of the branching techniques used in the software is presented.		

* Rating: 3 - High 2 - Medium 1 - Low

** Weight: 3 - Very Important 2 - Important 1 - Little Important

Overall Evaluation and Recommendations

Evaluator Record

Name:	Signature:	Affiliation:

Title:

The Effect of Lesson Structures on Predication and Inference

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The Effect of Lesson Structures on Predication and Inference

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Introduction

One of the most important goals of instructional design is to help learners to develop capabilities to solve situated real life problems. Students should not only be able to memorize instructional contents, but also be able to make inferences and generate problem solving solutions in novel and complex situations. Traditionally, it is believed that if we can help students to learn abstract rules and principles, they will be able to apply them in a variety of situations. School mathematics, for example, provides abstract principles for different kind of math operations. However, as many researchers have come to realize, the students often cannot apply the rules and principles in real life situations. Rather, they tend to treat them as something to be memorized. When instructional content is taught context independently, students are less likely to be able to see the utilities of information sources in real life situations. (CTGV 1992).

Anderson (1980,1982) proposes that there are two kinds of knowledge representations, declarative knowledge and procedure knowledge. Declarative knowledge consists of network of schema and procedural knowledge consists of network of goal oriented production rules in "If-Then" format. When students encounter novel situation, they rely on existing networks to make inference and generate solutions. Learning is the process of connecting new information to the existing schema and production network and adjusting the existing network to assimilate the new information. When instructional content domain is well structured, the maps of schema network and production system can be clearly defined. Instructional programs based on systematic instructional design models can be very effective in this situation. However in many cases we are facing a more complex world.

The complexity of situation is reflected in at least two aspects.

First, learners construct their meaning and their knowledge representation according to their physical, psychological and social context and prior experience (Duffy and Jonassen, 1992). Each student constructs his/her understanding and knowledge representations in learning experience. While common understanding and communication are made possible by social negotiation of meaning, learning is a process of active seeking of personally owned meaning in context.

Second, many domains of learning are illstructured (Spiro, et al., 1987). This illstructuredness is reflected by the fact that there is no apparent set of concepts or principles that are constantly accurate and applicable to every case in the domain. Each case is different from any other cases, therefore, predefined production rules often fail to address certain situations and rigid schema structure can not describe complexity of the domain. Spiro and associates (Spiro, Coulson et al. 1988) propose that one of the major problems of traditional instruction is reductive bias. Instruction often over-rely on a single or limited number of examples or prototypes, therefore, in many illstructured domains, complex structures are artificially oversimplified. The result is compartmentalized knowledge with rigid structures that are not very useful or usable in real life problem solving situations. Memorization often takes the place of the hoped-for transfer of the abstract knowledge.

Cognitive flexibility theory was proposed (Spiro, et al., 1987, Spiro, et al., 1992) to help students to master the complexity of instructional contents, especially in advance and illstructured domains. Cognitive flexibility theory is based on the idea that learners should be exposed to as many perspectives of the knowledge as possible and they should also experience different cases of the domain. By "Criss-crossing" the domain in different cases and from different perspectives, the students will be able to achieve flexible understanding of the domain and its complexity. With the flexible understanding, they will also be able to assemble their knowledge to solve new problems.

To address the question "how do we help students to acquire knowledge and skills that are usable in real life situation?", anchored instruction (CTGV, 1990; CTGV, 1993), as a prime example of case based situated learning environment, provides an authentic and generative learning environment in which students generate subgoals to meet the challenges afforded by the case. Very rich context information helps students learn and use mathematics in the way that they can see how information can be relevant and useful to solving the problems, rather than just something to memorize. Brown, Collins and Duguid (1989) argue that for learners to be able to obtain usable knowledge, learning should be situated in authentic context and activities. Contextualization of learning, or learning *in situ*, therefore, is believed to be an effective way to help the students achieve meaningful learning. Case based learning environments are suggested to provide rich context for learning and meaning making.

While cognitive flexibility theory does not particularly prescribe that the cases for the students to criss-cross should be authentic real life cases, it is not difficult to see that cognitive flexibility theory can go hand in hand with situated learning in case-based environments, especially when the domain of instruction is illstructured and the use of domain knowledge is often expected in real life situations. For example, almost all business students have some exposure of management information system (MIS). One of the most important concept in MIS is that information is shared in enterprises. However, for different people in the organization, an information system provides different kinds of access and different information systems function differently in different business settings. Apparently, this is not a clear-cut topic. The better the students understand the complexity, the more likely they will function effectively in real business operations. What if we design a learning environment that incorporates the assumptions and strategies of both situated learning and cognitive flexibility theory to teach enterprise information system?

Purpose of the Study

The purpose of this study was to compare the effectiveness of two different lesson structures on helping students make inferences and predictions after studying a computer-based lesson of interdepartmental information system. This subject topic was required by undergraduate business majors at most universities.

There were two different implementations based on different lesson structure, which were case based cognitive flexibility structure (case-based structure henceforth) and concept based lesson structure with examples (concept-based structure henceforth).

Case-based lesson was implemented as a cognitive flexibility hypertext. There were four cases in the lesson. Two cases were generic cases in which context information was fairly simple and the other two were very rich cases with heavy contextual information such as where the stories happened, what kind of enterprises they were and so on. Different departments of the enterprises were represented by different on screen figures of the departmental heads with talking balloons. Their perspectives were presented by the words of the department heads with the cases as contextual support. The talking balloons contained reflections of these department heads regarding to how information was accessible to the department, how the department contributed to the shared information system, and how the information system helped and influenced their business plans and practices. The case scenarios provided a context on which they could reflect.

The implementation of concept-based lesson presented the basic lesson content first. The basic lesson content covered similar information provided by generic cases in case-based lesson implementation. However, the information was presented as concepts and principles in outline and bullets format. After the basic information presentation, two examples were used as support of the concepts and principles. The examples used were similar to the context rich cases in case-based implementation, however, the presentation did not emphasize the contextual information.

The study tests the following hypotheses about lesson structure.

1. Students in case-based lesson make better inferences from given information.
2. Students in case-based lesson predict outcomes of new situation more accurately based on new information.

Method

Participants

Three hundred and eighty-one sophomore business students from a large eastern university comprised the sample. They did not have prior knowledge about the subject matter area covered by the lessons and volunteered to participate this study.

Measurements

At the end of the lesson, the students were given a test with 10 multiple choice questions on prediction, 9 multiple choice questions on inference. These questions were randomly mixed. The time that students spent on the program was recorded. The following are example questions for prediction and inference respectively.

- Predication:

The Profit-Vision program that analyzes all of the stores' sales should produce what operational effect:

a. quicker collection of receivable
b. slower collection of receivable
c. higher in-store inventories
d. lower in-store inventories

• Inference:

The most important advantages of Frito-Lay's information system are centralizing the data collection and:

a. providing regional managers access
b. centralizing data processing
c. expanding the number of collection sites
d. predicting the volume of sales

After finishing the lessons, students also took the first part of Necessary Arithmetic Operations Test (French, Ekstrom et al. 1963), which measured the general reasoning factor. This test consisted of 15 multiple-choice questions that required the test taker to determine what numerical operations were required to solve arithmetic problems without actually having to carry out the calculations.

Treatments and Procedure

Two versions of the lesson were developed. The first version was a concept-based implementation which used examples to help on conveying main concepts and principles to the students. This version of lesson was used in concept-based group. The second version was case-based. It was implemented as a cognitive flexibility hypertext environment with rich cases and contextual information. These two versions were placed on the college LAN server under different names. Each student copied one of the three versions onto his/her own disk. After students' finishing the lesson, the responses were recorded on the disks.

The student volunteers were randomly assigned to one of the two groups using one of these different versions. They were asked to work independently. The students finished the lesson in a period of one week and turned in their answers on floppy disks so that their answers could be retrieved.

Results

There was no significant difference between the average amount of time spent by the two groups (P>.05).

Table 1 presents the average inference and predication scores in case based treatment and concept based treatment respectively.

Table 1, Average of Inference Scores and Predications Scores in Two Treatments

	Case Based Structure	Concept Based Structure
Inference	4.11	3.80
Predication	5.09	5.01

A regression of Predication Scores on Time Spent on Task and scores of Necessary Arithmetic Operations Test (NAOT) is present in the table below:

Table 2. Regression of prediction on time spent on task and NAOT

Predictor	Coefficient	St. Dev.	t-ratio	p
Constant	2.78	0.27	10.29	0.000
Time	$2.98\ E^{-4}$	$6.75\ E^{-5}$	4.40	0.000
NAOT	0.20	0.03	7.27	0.000

s = 2.032 R-sq = 18.1% R-sq(adj) = 17.7%

A regression of Inference Scores on Time Spent on Task and scores of Necessary Arithmetic Operations Test is present in the table below:

Table 3. Regression of inference on time spent on task and NAOT

Predictor	Coefficient	St. Dev.	t-ratio	p
Constant	2.07	0.23	9.05	0.000
Time	$2.16\ E^{-4}$	$5.71\ E^{-5}$	3.79	0.000
NAOT	0.18	0.02	7.45	0.000

s = 1.721 R-sq = 17.5% R-sq(adj) = 17.0%

Table 2 and Table 3 show that both time and NAOT contribute significantly to the variances in distributions of Predication Scores and Inference Scores.

Using scores of Necessary Arithmetic Operations Test (NAOT scores) as covariate for Predication and Inference scores, two different treatments as independent variables, Table 3 and Table 4 present the results of Analysis of Covariance:

Table 4. Analysis of covariance for prediction with NAOT scores as covariate

Source	DF	ADJ SS	MS	F	P
Covariate (NAOT)	1	265.49	265.49	61.15	0.000
Treatment	1	0.19	0.19	0.04	0.835
Error	378	1641.13	4.34		
Total	380	1907.15			

Table 5. Analysis of covariance for inference with NAOT scores as covariate

Source	DF	ADJ SS	MS	F	P
Covariate (NAOT)	1	192.62	192.62	63.07	0.000
Treatment	1	7.61	7.61	2.49	0.115
Error	378	1154.37	3.05		
Total	380	1356.05			

Using scores of Time spent on task as covariate for Predication and Inference scores, two different treatments as independent variables, Table 5 and Table 6 present the results of Analysis of Covariance:

Table 6. Analysis of covariance for predication with time as covariate

Source	DF	ADJ SS	MS	F	P
Covariate (NAOT)	1	130.07	130.07	27.67	0.000
Treatment	1	3.11	3.11	0.66	0.416
Error	378	1776.55	4.70		
Total	380	1907.15			

Table 7. Analysis of covariance for inference with time as covariate

Source	DF	ADJ SS	MS	F	P
Covariate (NAOT)	1	78.31	78.31	23.33	0.000
Treatment	1	14.46	14.46	4.31	0.039
Error	378	1268.68	3.36		
Total	380	1356.05			

With either NAOT or Time scores as covariate, these results indicate that there were no significant different between students' scores on predication in the two treatments ($P<0.835$ and $P<0.416$ respectively).

With NAOT scores as covariate, ANCOVA for Inference scores did not yield significant results ($p<0.115$). However, it is worth noticing that when the time on task is use as covariate, ANCOVA for Inference scores yielded significant results ($P<0.039$). This indicates that if we partition out the variance brought about by how much time the students spent on task, the different treatments then demonstrate significant impacts on the students' capability to make inference. The students in case based treatment performed better on making inference than those in concept based treatment.

Discussion

The results indicate that both the time on task and NAOT scores contribute positively to inference and predication scores. The more time the students spent on task, the higher their inference and predication scores tend to be. While NAOT is a measure of flow of reasoning(French, Ekstrom et al. 1963), it is reasonable to believe that time on task is an indicator of how much mental efforts that the students made in the lessons. It is therefore not surprising at all that they both help the students to perform better in make predications and inferences.

By using ANCOVA as a means of statistical control, we were able to isolate the effect of instructional treatments, lesson structures in this case, by separating the contribution of time and NAOT scores. As table 4 to table 7 indicate, different lesson structures did not contribute to the variance in predication score. In other words, the difference in the students' performance of making predication is statistically insignificant.

However, if we take the contribution of time on task into account by using it as a covariate, it became clear that students in case-based treatment perform better in making inferences. This provided some empirical data that support both cognitive flexibility theory (Spiro et. al. 1987, 1992) and situated learning theory (Collins, 1991). In case-based lesson, the different perspectives served as different themes that helped the students criss-cross the knowledge landscape in different cases. These flexible knowledge representations helped them in making inferences from given information. The rich contextual information also helped students to make rich connections in their schema and production network (Anderson, 1980). These relatively more complete networks also helped the students to infer.

Conclusions

The time that the students spent on tasks and the reasoning ability, measured by Necessary Arithmetic Operation Test, contributed significantly to the students' performance of make inferences and predications. The students performed equally well in making predications in different lesson structures (cased based and concept based). In making inference from given information, the students in case based lesson performed better than those in concept based lesson did. It is suggested that the multiple perspectives and rich contextual information in case based lesson structure afforded students to understand the inter-relationship and connect the information into better representations, which helped the inference making process.

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Title:

The Reality of Corporate Education

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Background

Widespread change is dramatically altering the traditional face of the workplace. Offermann and Gowing (1990) state, "The nature of work, the work force, and the workplace have undergone and will continue to undergo enormous change, bringing both upheaval and opportunity for those involved in organizations" (p. 95). This rapid change is creating new problems and conflicts which call for new interventions and strategies (Dick, 1993; Goldstein and Gilliam, 1990).

One of the emerging problems in the field of Instructional Development (ID) is the widening gap between theory and practice. Consequently, practitioners are faced with a dilemma. On the one hand, they would like to apply the well-structured theories learned from schools. On the other hand, they find that these precise theories are less practical in the field. All professionals in the "bottom-line driven" corporate world, must adopt a more flexible, situational approach in order to get the job done as smoothly and as cost-effectively as possible. Corporate ID practitioners are no exception (Boutwell, 1979; Dick, 1993; Rossett, 1986; Stolovitch, 1981).

This presentation will first examine the gap between ID theory and practice. A conceptual framework will then be proposed to illuminate how expert ID practitioners work in the corporate world.

Gap between ID Theory and Practice

Over the years, the bulk of instructional development research at the macro level has focused on model-building (Andrews & Goodson, 1980; Taylor & Doughty, 1988). Theoreticians identified critical ID component tasks, organized them in a logical, linear sequence, and suggested that practitioners follow them systematically and thoroughly (Gustafson & Tillman, 1991). But, this strictly step-by-step procedure does not reflect the ID process as practiced in the field, since it is what works that counts in the product-oriented corporate world.

Until recently, little formal research had addressed this critical issue of weighing and prioritizing ID tasks, let alone the crucial decision-making processes involved, or the judgment concerning the quality of decisions made. It is also noted that special attention is now being given to social, political and cultural influences in corporate education. Thus, ID professionals may have to immerse themselves in diverse human and social factors while inquiring into this line of research (Heinich, 1984; McCombs, 1986; Shrock, 1985; Tessmer & Wedman, 1990).

Based on observations of recent developments in both ID and other related fields, it also becomes obvious that ID theory and practice are greatly influenced by the social context in which diverse professions interact and enrich each other. Thus ID, in its nature and practice, must be considered an interdisciplinary profession. By taking this approach, the existing strengths, experiences, and resources of the ID profession can be optimally enhanced.

All this is leading to the emergence of a more flexible, situational and social approach to ID. This context-sensitive approach, as opposed to the classical, mechanistic mode, will accelerate the development of a coherent set of ID theories and practices. The implication which emerges from an examination of these issues in the literature and professional practice in the field is the urgent need to narrow the gap between ID theory and practice.

Professional Practice in Corporate Education

On the basis of the authors' lengthy experience in the field of corporate consulting, we propose a conceptual framework to describe how expert ID practitioners work in the corporate reality. This framework consists of five major themes, which are:

(1) cultural context,
(2) situation analysis and synthesis,
(3) client and other stakeholders,
(4) performance capacities (capacity analysis and professional ethics),
(5) competitive advantages (business strategy, professional conduct, and changing roles).

As Figure 1 illustrates, under the umbrella of cultural context, a project brings the practitioner and the client systems together. The practitioner strives for the project's success by conducting situation analysis and synthesis, analyzing performance capacities, and cooperating with the client and other project stakeholders. The practitioner operates within a framework of professional ethics, and exercises three competitive advantages consisting of business strategy, professional conduct, and changing roles.

In the following sections, although each key theme is addressed separately, it should be noted that each theme has a unique, sophisticated, interwoven relationship with the others.

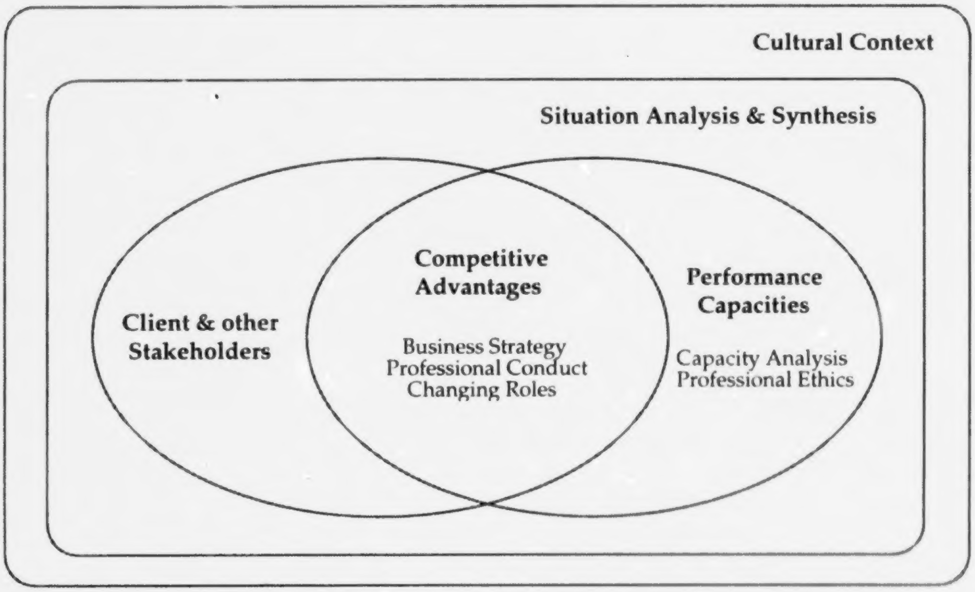

Figure 1: Themes of Corporate Education (from research on "The impact of situational factors on the corporate instructional development practitioner's decision making," Liang, C., 1994)

Cultural Context

In this paper, cultural context is defined as the specific context in which the ID project is carried out under a set of traditions, values, beliefs, and influences of the contemporary society. In other words, the cultural context of a specific society is closely associated with the shared values and traditions in that community. It engenders a complicated network of that group's concerns and beliefs in which the conventional traditions are intertwined with emerging contemporary issues. The new values resulting from contemporary concerns may conflict with the tradition ones.

This cultural context acts as a filter to help ID practitioners preserve those things which fit, but to leach out those which do not. It directs their conduct: it leads them to think, to believe and to act.

Situation Analysis and Synthesis

The real-world situations which corporate ID practitioners faced are dynamic and few are covered by the theoretical methods learned from textbooks. From the outset of each project, in fact even before they take on a project, practitioners need to closely analyze the situations they are likely to encounter, and to constantly synthesize their findings.

In other words, in this dynamic environment, expert practitioners change or modify their approaches as the ID process evolves. As each situation arises, they interpret its meaning by combining the new contextual information with their previous information and experiences. Their subsequent interpretations bring into focus the risks and opportunities inherent in this new situation. The practitioners then take action to minimize these risks and optimize the opportunities.

Experienced practitioners are always on the alert for unexpected or rapid changes. They continually probe for relevant information, asking themselves if there are any better options. They flexibly adjust their mindsets and take action, first by integrating the new inputs, and then by visualizing the consequences of their subsequent choices. This ongoing process allows them to take account of their emerging insights and to revise their decisions accordingly.

For the most part, ID decisions in professional practice cannot be judged simply as right or wrong. Much depends on the practitioners' interpretations of the situations and on the possible outcomes they wish to achieve. Thus, situation analysis and synthesis is aimed at achieving full utility of the resources and the interventions available at that specific point in time. How well practitioners optimize this integration largely depends on how well they understand the problem and the client system.

Client and Other Stakeholders

To meet their client's needs and to carry out their projects effectively, experienced practitioners direct their energies to the right place by asking, "Who is the real client?" and by strategically distinguishing between "their success" and "their clients' success."

The aim of expert practitioners is not only to satisfy, but to delight their client and to impact the client's organization. To this end, they collect information which enable them to grasp the client's intention, agenda, policy, expectations, and standard. Not only do they comprehend their client's needs, but also those of the other project stakeholders. Expert corporate practitioners are committed to having a deep understanding of both their clients' industries and social dynamics which smooth out the process and facilitate their projects' successes.

Expert practitioners also create communication channels to listen to those clients who are closest to the problems and their solutions. They are sensitive to and follow their clients' organizational ecology to increase their clients' buy-in. These practitioners also play different roles in response to their clients' various needs and to the situations they encounter.

When conflicts arise among their clients and other project stakeholders, even at times involving the practitioners themselves, the practitioners may be caught in an ethical dilemma. This growing awareness of and concern for the stakeholders' needs and benefits demonstrates a new movement beyond "customer satisfaction" to "social satisfaction."

Performance Capacities

The practitioners' performance capacities can be divided into two categories: capacity analysis and professional ethics. On the one hand, capacity analysis includes an examination of the professional competencies, the resources and other tangible means necessary for the practitioners to carry out their projects. Professional ethics, on the other hand, represents the impact of spiritual power such as values, mindset and morals on the practitioners' decisions and actions. Unless the practitioners dovetail their performance capacities with their clients' needs, their projects are unlikely to have fruitful outcomes.

Capacity Analysis

In this section, capacity analysis is discussed at three levels: organization, team, and individual. It is capacity analysis at these three levels which allows each practitioner to predict the most productive route to take during a project, and to orchestrate those performances which will produce a coherent whole.

Organization capacities

Capacity analysis at the organizational level includes an examination of the history, mission, values, culture, leadership, resources, structure and politics of the practitioner's own organization.

Team capacities

At the team level, an accurate capacity analysis helps the practitioners to define and bring together the appropriate capabilities and resources which enable them, as project managers, to lead their teams' efforts toward their project missions.

Individual capacities

Capacity analysis at the individual level includes a close inquiry by the practitioners into each potential team member's competencies and the resources at hand. This allows them to marshal and allocate the appropriate capacities and to make best use of them at the individual level.

In sum, the organization, team and individual capacities available to the practitioners must match their clients' needs in order to guarantee a win-win result.

Professional Ethics

The second category of the practitioners' performance capacities is professional ethics. Professional ethics represents the impact of spiritual power such as values, mindset and morals on the practitioners' operations. It is the criteria to which the practitioners refer when they wish to justify a decision. Professional ethics are objectively regulated by system rules such as laws, formal guidelines and societal norms, and are subjectively bounded by personal values, beliefs and cultural background.

Expert practitioners consistently demonstrate high ethical standards which guide their personal and professional conduct. Cultural context and the diverse conflicts of interest which arise among the client and various project stakeholders have a determining influence on the practitioners' ethical practices. Practitioners constantly mediate the tensions between a generalized duty owed to society and to their profession vs. the specific duty owed to a particular client. And, they reconcile the tensions between the ideal of a general principle and the reality of a particular practice.

Competitive Advantages

Expert corporate ID practitioners strive for their projects' success by exercising three competitive advantages: business strategy, professional conduct, and changing roles. It is these three competitive advantages which make these practitioners uniquely successful.

First, business strategy represents the collective schema of the practitioner's organization, which creates a vision and sets up a direction for future action. Next, professional conduct signifies the actions which mobilize all the resources necessary for the practitioner to enact the constructed business strategy. Finally, changing roles symbolize both the capacity for flexibility within a project and a movement toward continual professional development as the practitioner works in the field and grows from the experience.

Business Strategy

Business strategy is the unifying idea that links together the functional areas in a company and relates its activities to its external environment. It results in no immediate productive action, but sets a general direction in which the company's position will grow and develop. It is the means to the company's ends.

In implementing business strategy, expert practitioners go beyond success. Not only do they strive to satisfy their clients' needs, they aim to delight their clients. They push the limits of their professional boundaries, and promote their own organization's image in society. At the same time, they extend the focus of their concerns beyond their clients' needs to encompass the other relevant project stakeholders' benefits. This signifies a movement from "customer satisfaction" toward "social satisfaction".

Professional Conduct

Professional conduct is the second of the expert practitioners' three competitive advantages. While business strategy sets the general direction for development, professional conduct represents the practitioners' actions which enable the implementation of the constructed business strategy.

The professional conduct of expert practitioners is directly influenced by each theme discussed in this paper, or by various combinations of these. In striving for their projects' success, the practitioners' professional conduct is always aimed at achieving a win-win outcome for their clients, the relevant stakeholders, their own organizations and themselves.

Changing Roles

Changing roles is the third competitive advantage which expert practitioners exercise. Throughout each project, they wear "multiple hats" (they exhibit the ability to function in multiple capacities) to meet the wide range of their clients' needs. At the same time, they also apply the experience they accumulate from their projects to facilitate their own professional growth. In other words, changing roles represents the process of continual professional development from a single-specialty practitioner to a holistic organizational consultant.

But, no matter which roles these practitioners play throughout the course of their projects and their professional lives, they always play the role of competent helper.

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Title:

Using a Hypertext Environment for Teaching Process Writing: An Evaluation Study of Three Student Groups

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Abstract

The present research consisted of a comprehensive evaluation of a hypertext model for teaching process writing at the junior high and high school level. Interests were to determine how two teachers and three different age groups of students used and reacted to the model, specifically, its embedded design features of model stories, note cards, idea buttons, mini-lessons, branching buttons, and cut-and-paste-tools. Results showed applications of the embedded features to vary based on teacher attitudes, feature attributes (e.g., ease of use and appeal), and student characteristics. Older students made more usage of many of the features, but were less positive about the hypertext model given their greater involvement with completing writing assignments rather than with exploring new forms of writing. The implications of the results are discussed regarding the instructional design and classroom implementation of new technologies for teaching process writing strategies.

Using a Hypertext Environment for Teaching Process Writing: An Evaluation Study of Three Student Groups

Several reports have recently documented the decline of writing skills of American students (National Assessment of Educational Progress, 1990; Walton, 1990). Although basic composition skills appear "adequate," students show limited success with writing tasks that involve higher-order thinking and reasoning (Applebee, Langer, & Mullis, 1990). Directly relevant to the focus of the present research is the difficulty today's students experience in using imaginative writing skills to create original stories (Stein, 1986; Walton, 1990).

One approach to the challenge of improving students' higher-order writing ability is "process" orientations to teaching writing. In contrast to "product" orientations that emphasize mechanical skills such as punctuation, spelling, and grammar, process orientations stress writers' personal construction of meaning and structure (Resnick, 1987). The process orientation also emphasized a social context of student conferencing during the various non-linear writing stages of planning, generating, revising, and evaluating (Bereiter & Scardamalia, 1986; McGee & Richgels, 1990).

The following four assumptions underlie the design of process writing strategies: (a) writing is a process of constructive problem solving, and through writing practice, students develop thinking and writing skills; (b) experts and novices approach the process differently; (c) writing is recursive, drawing on many stages of writing randomly rather than linearly or sequentially; and (d) the strategy the writer takes is dependent on the purpose and nature of the writing task (Hildyard, 1992). Most school-based process models of instruction describe the following five stages (Calkins, 1986; Hillerich, 1985; Madden, Wasik, & Petra, 1989; McGee & Richgels, 1990): (a) rehearsing or planning, (b) drafting, (c) revising, (d) editing, and (e) publication. However, a well formulated theory does not guarantee a successful application. The effectiveness of such approaches in improving students' writing skills is yet to be established. Probably the most widely stated criticism is that process approaches are applied too superficially (Applebee et al., 1990; Calkins, 1985; Resnick, 1987; Stein, 1986). Frequently cited consequence is that students may not be able to transfer process skills instruction to the types of writing tasks they confront in real-life contexts.

The problems encountered with applying theoretical models to everyday situations are not unique to writing instruction. Incorporating thinking skills within specific disciplines remains an important challenge for educators in the domains of problem-solving (Resnick, 1987) and addresses the need for the development of prescriptive research methodologies (Clark, 1989).

Computers and Process Writing

Word-processing technology is generally believed to support process orientations because it carries the potential to remove many of the mundane and time-consuming barriers to writing (Bruce, 1991; Daiute, 1992). A typical claim is that students who spend less time in mechanical activities of rewriting, revising, and restructuring can spend more time problem solving, thinking, and planning. Although there is a widespread belief that word processing facilitates writing, research has yet to show that it directly fosters writing improvement (Cochran-Smith, 1991).

An increasingly used computer application, hypertext, is intuitively promising because its non-linear structure suggests an ideal environment for writing instruction within a process framework. Hypertext is the label for computer-driven displays of information that can display information in various combinations. In a hypertext environment, information can be connected or linked to any other information contained in that environment. Because of linking and branching capabilities, the structure of hypertext is frequently compared to the structure of human memory (Conklin, 1987; Jonassen, 1991; Warren, 1989), and as such can be designed for a multitude of instructional uses.

Features of hypertext that may enhance traditional word-processing capabilities include the capability to revise and restructure; to branch to alternative arguments and/or descriptions (Bolter, 1991); to embed notes, tips, and elaborations; to store writing sequences from past sessions (Neuwirth, Kaufer, Chimera, & Gillespie, 1987); and to model expert decisions (Jonassen, 1991). All of these features may facilitate non-linear aspects of writing and suggest that hypertext may be an attractive tool for supporting the decisions of writers while they are structuring knowledge.

Although hypertext promises great potential for writing instruction, its effectiveness in this area still remains in question. Several development projects illustrate varied applications of hypertext writing environments, but have not encompassed systematic investigations of learner processes and outcomes. These projects include (a) Notecards, a collaborative writing project (Trigg & Suchman, 1989); (b) the Writing Environment, featuring planning, writing, and editing modes based on cognitive learning principles (Smith & Lansman, 1988); (c) Hyperstories, a combination of HyperCard™ and a videodisk program used for teaching and story writing on ecological issues (McLellan, in press); (d) Multimedia Stories, a multimedia composing tool (Daiute, 1992); (e) and the Apple Classrooms of Tomorrow study of children using multimedia software, StoryShow, in co-authoring stories (Reilly, 1992).

Purpose of the Present Research

Problems with implementing general design models, such as process writing, are widely reported in many academic disciplines (Resnick, 1987) and have become a challenging issue for the field of instructional design and technology. Hypertext may be a promising tool for addressing the problems related to implementing the strategies of processing writing within a classroom structure. One advantage would be incorporating, within the hypertext design, strategies that handle many of the sizable management tasks associated with the process approach. Additionally, the modeling of expert knowledge structures important to story writing suggests an effective way to teach specific thinking skills.

The present study investigated the effectiveness of a hypertext writing environment specifically designed to facilitate process model instruction. The program contained several embedded features to stimulate and support usage of task-relevant problem solving and thinking skills during writing activity. Included were note-taking, mini-lessons, teacher- and student-generated writing suggestions, sample stories, branching cards, and teacher- and student-modeled writing samples. The basic writing model consisted of six-week writing unit in which students were trained on using hypertext, read sample stories, and wrote original stories using the embedded features. Research outcomes of interest were students' usage of the embedded features, students' and teachers' experiences during the implementation period, and the nature and quality of process writing products. The research orientation represented an applied descriptive study or an evaluation study (Ross & Morrison, 1994). Despite its emphasis on a particular instructional model, findings were also expected to suggest general principles for improving the effectiveness of similar applications (i.e., hypertext contexts) for writing instruction and other curriculum areas. Specific research questions were as follows:

1. To what extent do the embedded features of hypertext facilitate process model instruction in the categories of: (a) problem-solving and writing, (b) expert modeling, (c) non-linear/recursive writing, and (d) story writing strategies?
2. Is usage of the above features associated with improved writing products?
3. Are there age and gender differences in embedded feature use and attitudes toward the process writing model?

Method

Design and Subjects

We employed a descriptive, naturalistic evaluation design in which a hypertext process writing model was implemented with 16 junior high and 22 high school students over an eight-week period. The model was implemented as part of the students' regular curriculum and classroom activities. Students attended a private school with strong liberal arts orientation and that serves a mostly upper-middle class student population. As a function of the naturalistic design, special characteristics of the student population, and relatively small sample sizes, multiple data sources, both quantitative and some qualitative, were used in conjunction with intensive study of student activities during all phases of the study. For the qualitative elements, we followed suggestions in the literature for achieving high internal validity by incorporating prolonged engagement (an eight-week study), persistent observations, triangulation of data sources, peer debriefing (discussion with the observer about motives, rationales, possible biases, etc.), and member checking (confirmation of results by participants) (Lincoln & Guba, 1985; also see Gallo & Horton, in press).

The junior high group consisted of a 7th-grade microcomputer class, taught by the computer teacher, that met for four 50-minute sessions a week. Eight males and eight females were in the class. The high school group was a combined 9th- to 12th-grade class that also met for four 50-minute weekly sessions. There were 13 males and 9 females in that class. All students participated in the researched writing tasks as part of their normal class activities which included computer-based writing as a component. Ninth graders ($\underline{n} = 10$) were enrolled in a microcomputer class emphasizing writing, while the 10th-12th graders were enrolled in a "Writer's Workshop" course also focusing on writing. (For clarity, we will henceforth refer to this group as the WW students.) The ninth-grade and WW classes were taught by the same high school teacher who specialized in English and computer-based writing.

According to the high school teacher, most of her students were familiar with the process model of writing as a function of its being practiced informally by most language arts teachers in the school. The microcomputer teacher described her students as being less familiar with the process approach, but as having basic computer skills (e.g., using a mouse, opening and saving files, etc.). For purposes of examining how students differing in age, experience, and course orientation would react to and use the hypertext writing model, we felt that the most appropriate breakdown for comparison would consist of three groups: 7th-graders, 9th-graders, and WW students.

Instructional and Evaluation Materials

The hypertext writing program was implemented over an eight-week period, of which two weeks were used to field test the program using individual students and small groups of students, and six weeks were used for classroom story writing. The six-week session included one week for an introduction to writing in hypertext with a practice activity, and five weeks of story writing in which students wrote two original stories.

The Hypertext Story Writing Environment

Students were given a HyperCard stack that contained five embedded strategies (accessed through HyperCard buttons) to facilitate usage of elements of the process model. Figure 1 illustrates the incorporation of the strategies; a brief discussion of each strategy follows (for more detailed descriptions, see Lohr, 1993).

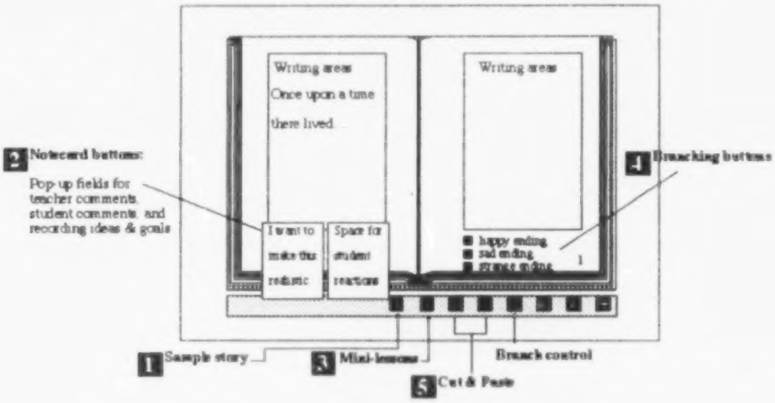

Figure 1. A view of the hypertext writing page with embedded features.

1. Sample story. The Frog Princess, a Russian folk-tale, was adapted to provide a hypertext sample story incorporating the author's embedded notes and examples of computer branching to different endings. Students were given the option to revise the Frog Princess by creating branches to different beginnings, character descriptions, and character actions. The sample story was intended to reinforce a process writing orientation by conveying writing as constructive problem-solving in which the author reflects on and tries out different ideas.

2. Note card buttons. Two types of note cards were linked to each page using HyperCard buttons (see Figure 1). Goal-statement note cards provided an edit field to list one's writing goals. Prompts were displayed to remind students to use the goal statement button for recording their writing plans before leaving the page. Editor note cards provided edit fields for the teacher (or classmates) to record feedback comments for that page. These fields were hidden

from view until the critic or author clicked the appropriate button to view the fields. Students were initially told and intermittently reminded to read an embedded mini-lesson (see below) that instructed them on questions to ask when reading another student's story. The goal statement and editor note cards were used primarily to support four process writing components: (a) problem-solving and (b) planning through the setting of writing goals and recording of writing problems, (c) expert level suggestions through the editor feedback, and (d) revising.

3. Mini-lessons. Six mini-lessons were embedded in the students' writing stack following the suggestion by Calkins (1985) that brief, informally-introduced and well-timed instructional units covering topics important to writing development should be made available as needed during writing activity. Students could directly access any of the following mini-lessons during their writing: (a) basic story structure; (b) effective branching techniques; (c) choosing a topic; (d) conferencing; (e) rehearsal and revision strategies; and (f) "to do today," a list of teacher suggestions and reminders by clicking on the Mini-lessons button (see Figure 1). The stack would then branch to the appropriate mini-lesson. The mini-lessons presented instruction on two major process writing characteristics, writing as a non-linear activity and usage of specific story writing strategies.

4. Branching buttons. Branching buttons, provided as an option on each HyperCard page, allowing the student to create up to three written detours from each writing page (see right page of Figure 1). Branching could be used to tell a story from different perspectives (e.g., a happy or sad ending) or for elaborating and exploring story ideas for possible use in the actual story. The branching component most directly addressed the non-linear nature of process writing, along with problem solving, and planning. After clicking a branching button, the student could write a new section which was linked to the original story. Each branch could subsequently be evaluated by clicking the appropriate branching button which would then display the branch.

5. Cut-and-paste buttons. Cut-and-paste buttons (see Figure 1) allowed students to move sections of text without the need for retyping. This feature directly supported the process writing components of revising and editing. Students could highlight the text they wanted to copy or paste and the click the appropriate button. The cut-and-paste buttons were added as an alternative to the Cut-and-Paste items under the Edit menu.

Data Collection Instruments

Eight types of instruments were employed to collect quantitative and qualitative data relevant to the research questions. An overview of the instruments is provided in Table 1; a description of each follows.

Observer notes. Observer notes were recorded daily by the first author during study writing sessions. These notes contained descriptions and impressions of the activities as well as reactions expressed by students and teachers regarding their experiences with the writing tasks.

Frequency counts of embedded feature use. Frequency counts were automatically collected by the computer from every student during each writing session, indicating uses of note cards, mini-lessons, branching tools, and cut-and-paste procedures.

Holistic writing assessment. Holistic ratings of story quality were made by the two classroom teachers for the two stories written by students. The following holistic scales was used:

0. Not rated: stories were absent, unreadable, or unrelated to the story writing task.
1. Unsatisfactory: stories were abbreviated, incomplete, circular, or disjointed, and did not address the story-writing task.
2. Adequate: some elements of story structure were presented and the story was moderately engaging.
3. Elaborated: story exceeded the essentials, providing additional coherence and detail to create an interesting and coherent theme.

To establish inter-rater reliability and refine the rating scale, the two raters initially selected at random three student stories from the entire set, scored that selection, and compared their ratings. Variations in scores were followed by discussion, which initially prompted the decision to combine two categories in an original five-point scale into one category to yield the above four-point scale. Also, additional descriptors were added to categories of the original scale. Following these revisions, eight additional stories were rated independently by each teacher, with a resultant inter-rater reliability of $r = .83$. The teachers again discussed any discrepancies to increase the validity of subsequent ratings. Overall inter-rater reliabilities on the complete story sets were quite high for both Story 1 ($r = .94$) and Story 2 ($r = .93$).

Table 1.
Summary of Data Collection Instruments Used

Instrument	Descriptor
1. Observer Notes	Each day: Written descriptions and impressions of each session were recorded in a journal.
2. Frequency of embedded feature usage	Each Day: Computer-recorded tabulations of the number of times each student used: a) Note cards b) Mini-lessons c) Branching d) Cut-and-paste
3. Holistic writing assessment	Story 1 and 2: 4-pt. rating of the quality of students' stories.
4. Student questionnaires/interviews	a) Week1: 8 ratings (5-pt. scale) on attitudes toward and experiences with writing, computers, process writing. b) Week 6: 22 rating items on attitudes toward and usage of embedded features, reactions to hypetext and its effectiveness. c) Week 6: 11-question interview on attitudes and experiences.
5. Teacher interview	Week 6: 17-questions on experiences with and attitudes toward the hypertext and the writing process.
6. Problem-solving analysis	Each day: 2 or 3 students story stacks were selected for qualitative analysis
7. Weekly records	Each week: Analysis and evaluation of students' modeling strategies, embedded feature use, and teacher-embedded instructions

Student questionnaires and interview. Students completed two questionnaires, both using five-point Likert-type scales (1 = "strongly disagree;" 5 = "strongly agree") for responses. The initial questionnaire, administered during the first week of the study, contained eight items that addressed attitudes about writing and computers, and experiences with the process approach to writing (e.g., "I often share drafts of what I write to see how others react"). The second questionnaire, administered at the conclusion of the study, consisted of 21 items concerning attitudes about writing, computers, and specific hypertext features experienced (e.g., "I liked using the branching buttons").

All students were interviewed during the final week of writing to determine how they used and felt about the hypertext model. There were 11 interview questions, ranging in focus from general impressions (e.g., "Overall, how did you like the hypertext writing environment?") to reactions about specific hypertext features (e.g.., "What usually prompted you to use the mini-lessons?").

Teacher interview. The two teachers were interviewed at the end of the year. Questions addressing the following categories were asked: reactions toward the writing environment, student attitudes, ease of managing the writing environment, the instructional effectiveness of the writing model, most and least liked features, and suggested changes.

Daily records of problem-solving activity. Two or three student story-writing stacks were selected randomly each day for analysis of problem-solving activity. Based on qualitative analyses of initial samples, the following categories were derived for structuring the subsequent evaluations: generating ideas, expressing ideas, working with story structure, branching, originality, developing appropriate details, organizing, and "other."

Weekly records. Weekly analyses of student writings were conducted using: (a) the observer's analysis of modeling strategies used by the student, (b) frequency counts for the use of each embedded feature, (c) descriptions of how students used embedded features, and (d) an analysis of the nature of teacher-embedded instruction or help on story writing strategies.

Procedure

As described below, the implementation of the hypertext story writing program followed basic methodologies of the formative evaluation model suggested by Dick and Carey (1991). However, since the main purpose of the study was to assess the classroom implementation as it might be used by typical teachers interested in a hypertext process writing application, evaluation procedures evolved according to teacher interest and practical considerations as well as procedures of the formal Dick and Carey model.

Stage One

The first stage assessed ease of program use, employing one male subject (a 7th-grader) who was not part of the participating seventh-grade class. Observer notes were used to record impressions relevant to instructional and mechanical development (e.g., ease of use, perceived effectiveness of different components). Journal entries included the recording of subject responses to the writing environment via "think aloud" procedures (Schriver, 1989) in which the subject orally described his thought processes as he worked with the program. After completing the program, the subject was interviewed regarding his experiences and reactions. Based on the data obtained, appropriate program revisions were made.

Stage Two

Stage Two used a small group of three male students to test the revised program. Procedures were similar to those described for Stage One, except that think aloud procedures were excluded. Additional revisions of the program were made based on these results.

Stage Three

Stage Three was the actual study, conducted with the targeted junior-high and high-school classes. A six-week implementation of the completed hypertext program was organized. Week 1 was initiated with the administration of the questionnaire to assess student attitudes toward story writing. Students received instruction from the first author on using the hypertext story-writing program. Topics included opening the stack and leaving the stack, turning pages, and using embedded features. They then read a hypertext version of the sample story, The Frog Princess. They were also asked to read the mini-lessons on conferencing, branching, and choosing topics, and to use the lesson information in writing a new ending to The Frog Princess.

The students' assignment was to write two stories on any topic during the next five weeks. Students were asked to: (a) record goals and ideas in the goal buttons; (b) use the teachers' and other students' reactions for feedback, and record those reactions in the editor's buttons; (c) use the branching feature for at least one part of the story (WW students were explicitly required to branch); (d) provide feedback to other student authors; and (e) read the mini-lessons as they were introduced during the four-week writing period.

During this period, the first author recorded notes daily using the observer notes form. Copies of student stacks were made at the conclusion of each session. Weekly records of individual student and whole-class usage of hypertext features were also compiled. At the completion of six weeks, the follow-up student attitude survey was administered during a class period and the teachers and students were interviewed.

Results

The results are presented in four major sections addressing: (a) writing activities and products, (b) teacher and student attitudes, (c) hypertext facilitation of the process model, and (d) observer impressions. Where inferential analyses were conducted, the .01 probability level was used to reduce the family-wise error rate.

Writing Activities and Products

Story Characteristics and Use of Branching Applications

A total of 72 stories were written by the 38 student participants. The average story was approximately 10 hypertext pages in length, roughly equivalent to 5 standard double-spaced manuscript pages. The breakdown of story themes included: adventure-fantasy (33%), detective/mystery (24%), folk tale (7%), personal (7%), soap opera (7%), family (7%), futuristic (7%), and "no recognizable theme" (7%).

Branching was included in stories by 69% of the overall sample, 58% of the 7th-graders, 71% of the 9th-graders, and 93% of the WW students. The majority of branches (57%) were used to provide multiple story endings, such as "Click Branch A for the Happy Ending, Branch B for the Sad Ending." The next most common type (35%) was used for elaboration (e.g., "Click Branch A if you want to learn more."). The remainder (7%) comprised briefer forms of embellishment or motivational enhancement.

Story Quality

On the four-point holistic rating scale (0-3), mean scores for all students combined were 2.01 on Story 1 and 1.89 on Story 2. Thus, the typical student wrote a story that included some or most major elements and was "moderately" engaging. Less than 10% received the highest rating (3), indicating a more complete story structure, and sufficient coherence and detail to create an interesting and engaging theme. ANOVAs performed on the holistic scores using class and gender as independent variables showed neither factor to be significant (both p's > .05).

Embedded Feature Use

Table 2 provides a summary of the mean frequencies of embedded feature use for each group. As shown, students tended to use more of the features in Story 1 than in Story 2. The most frequently used options were teacher comments and student comments; least frequently used were cut-and-paste and branches.

Table 2
Hypertext Writing Environment Feature Use Totals

	Story 1				Story 2			
FEATURE	total F	mean	SD	med.	total F	mean	SD	med.
Teacher comments	283	7.44	2.95	.5	100	1.16	4.13	1
Student comments	231	6.08	4.70	5.5	51	1.34	2.55	0
Goal/Idea button	116	3.05	2.61	2	42	1.11	1.74	0.5
Branches	63	1.66	1.73	1.5	43	1.08	1.55	0
Mini-lesson use	114	3.0	2.50	2	26	.68	1.30	0
Cut-and-paste	91	2.40	4.56	0	11	.13	.13	0
Pages written[b]	227	5.97	2.95	5	157	4.13	3.31	5

[a] Mean is calculated by dividing the total frequency by the number of stories.

[b] Note that each hypertext page is roughly equivalent to 1/2 of a standard double-spaced page.

Comparisons between student classes, using one-way ANOVAs, showed significant effects on Story 1 for mini-lessons, $F(2, 35) = 8.14$, $p < .01$; cut-and-paste, $F(2,35) = 4.46$, $p < .01$; and branching, $F(2, 35) = 5.35$, $p < .01$. Follow-up analyses indicated that the WW students ($M = 4.75$) more frequently used mini-lessons during Story 1 than did the 7th-graders ($M = .50$). The WW students also used cut-and-paste tools ($M = 5.33$) and branching ($M = 4.08$) more frequently than did 9th-graders (M's = .50 and 1.50, respectively). No gender differences were found. Nor were there any class or gender effects on Story 2.

Pearson correlations between embedded feature scores and holistic writing scores were computed to explore whether writing quality was related to usage of any of the 6 features on either story. The resultant correlations ($n = 12$) were all positive in direction but nonsignificant and weak to moderately weak in strength, ranging in magnitude from .05 (cut-and-paste with Story 1 score) to .38 (student comments with Story 2 score).

Student and Teacher Attitudes

Initial Student Survey

Student responses on the initial survey showed moderately positive reactions to writing, with 75% of the sample agreeing that they liked writing, 60% agreeing that they liked using the computer for writing, only 20% agreeing that writing was difficult for them, and 10% agreeing that writing is difficult for others. About half of the students reported sharing drafts of writing with others and thinking about reader reactions while writing. Relatively few (from 10-25%) responded that they used the work of others while writing or experimented with different ways of writing a story. None of the chi-square analyses for class or gender was significant (all p's > .01).

Final Student Survey

Table 3 summarizes the percentages of students, broken down by class, agreeing with the individual item statements on the final survey, and the item chi-square probabilities for class and gender analyses. The only significant chi-square (at $p < .01$) result was for class ($p < .001$) on Item 1, "I like writing stories." Ninth-graders (19%) were less likely to agree with this statement than were 7th-graders (75%) and WW (75%) students. In general, students of both sexes in all grade levels had a high degree of confidence in their own and other's writing abilities, as indicated by the strong majorities (about 80%) who disagreed with the statements, "Writing is difficult for me" (Item 3) and "Writing is difficult for others" (Item 4). Approximately two-thirds (although only 30% of 9th-graders) agreed that they liked using the computer for writing.

Medium preferences. Across all classes, less than 40% of the students agreed that they would rather use HyperCard than word-processing (Item 5). On the other hand, only about 25% agreed that they would rather use a pen-and-pencil (than a computer) to write stories (Item 6) and about 60% agreed that they liked writing with hypertext (Item 7).

Ease of using embedded features. Although there were no statistically significant patterns, WW students tended to be slightly more positive than their younger counterparts regarding the use of most HyperCard features (branching, editor buttons, idea/goal buttons, and cut-and-paste). Five survey items asked students to rate the ease of using the individual embedded features (Items 8-12). Overall responses indicated that from about 60% (for mini-lessons) to 80% (for branching) of the students agreed that the features were easy to use.

Reactions to embedded features. Branching was the most liked embedded feature (about 55% overall agreement; Item 13). Editor buttons, goal buttons, and especially, mini-lessons were disliked by the majority of students (see Table 3, Items 14-16). The cut-and-paste feature was viewed positively by 75% of the WW students but by only 50% of the 9th-graders and 31% of the 7th-graders (Item 17).

Frequency of using embedded features. In responding to Items 18-22, students indicated generally infrequent use of the comment buttons (15% agreement), goal buttons (17%), and mini-lessons (14%); Slightly more frequent use of branching buttons (43%) and cut-and-paste (55%) was reported.

Attitude changes over time. Paired t-tests were performed comparing attitudes toward writing before and after the study. The first four ratings items (see Table 3) were used in these analyses. None of the comparisons of means approximated significance (lowest $p = .20$)

Table 3.
Percentages of Agreement by Class and Chi-Square Results on Final Student Survey

	Class			Chi-Square Probabilities	
Item	7th	9th	Writer's Workshop	Class	Gender
1. Like writing stories	75	10	75	.001	.05
2. Like using computer for writing	67	30	70	.36	.94
3. Writing is difficult for me	19	20	25	.92	.51
4. Writing is difficult for others	63	20	42	.07	.10
5. Rather use HyperCard than word processing	44	40	33	.26	.41
6. Rather use pen or pencil	25	30	22	.94	.19
7. Like writing with HyperCard	63	60	50	.79	.92
8. Easy to use branching	88	80	83	.87	.20
9. Easy to use editor buttons	44	60	75	.25	.59
10. Easy to use goal buttons	81	60	75	.48	.32
11. Easy to use mini-lesson	56	50	70	.44	.68
12. Easy to use cut-and-paste	69	70	58	.80	.14
13. Like branching	56	60	67	.85	.69
14. Liked editor buttons	25	20	58	.10	.19
15. Liked idea/goal buttons	25	20	58	.98	.59
16. Liked mini-lessons	25	0	17	.23	.38
17. Liked cut-and-paste	31	50	75	.07	.14
18. Frequently used branching	31	50	67	.17	.28
19. Frequently used comment buttons	25	10	33	.43	.35
20. Frequently used goal buttons	38	0	25	.09	.15
21. Frequently used mini-lessons	18	10	33	.39	.49
22. Frequently used cut-and-paste	44	50	75	.25	.02

Student Interview

Interview responses corroborated the survey results in all cases. In discussing their prior experiences, few students indicated any familiarity with process writing, while about 50% (more so for WW students) indicated having prior computer writing experience. About half indicated that they liked writing stories.

Positive aspects of hypertext. The most frequently given reasons for liking HyperCard were branching (f = 12), followed by ease of feature use (f = 10), and the visual aspects of the environment (f = 8). Comments about branching generally described the experience as creative, a good way to explore, and unique: 6% of 7th-graders, 50% of 9th-graders, and 42% of WW students made positive comments about branching.

Ease of use was described mainly in terms of liking the tools that were immediately accessible on the page, not hidden in pull-down menus. Positive comments were made by 31% of 7th-graders, 18% of 9th-graders and 0% of WW students.

Visual aspects were addressed in terms of how the environment resembled a book or page, or how the page sizes were small and unintimidating. Positive comments were made by 19% of 7th-graders, 30% of 9th-graders, and 0% of WW students.

Negative aspects. The most frequently given reason (f = 4) for disliking the hypertext writing environment was problems associated with the small page size. As one WW student described it, "The page size was so limiting, rather than being able to just write, you had to continually stop and prepare for the next page." Another student compared the limitations to "being on a slave ship, with too many paddles needed to move things forward." Other negative aspects, all expressed by WW students, were associated with computer problems (f = 2), dislike of writing (f = 2), and branching difficulties (f = 2). For example, one student indicated that branching bothered her because it complicated the writing of endings to the stories.

The view that hypertext was not helpful for problem solving was expressed by 75% of 7th-graders, 100% of 9th-graders, but only about 33% of the WW students. Specific comments by the two younger groups conveyed the general feeling that they did not have writing problems that needed attention. In contrast, the WW students were more self-critical and saw the helpfulness of certain features, particularly idea buttons and branching, for developing and incorporating ideas.

Facilitation of the process model. When students were asked specifically about idea development, more 7th-graders (81%) and WW students (55%) than 9th graders (20%) indicated that the hypertext environment was helpful. Several students specifically identified the idea button and branching as useful, but provided no explanation as to how. Negative comments stressed the spontaneous or internal nature of idea development, which reduced the need for external aids.

When asked directly if hypertext facilitated planning, agreement was expressed by one-third of the WW students, but by only one-fourth of 7th-graders and none of the 9th-graders. Almost all students disagreed that the hypertext writing environment facilitated drafting, which was not surprising, given that students were not specifically instructed to begin by writing a quick or "sloppy" copy.

In response to a question concerning how well the hypertext environment facilitated revision, about half of the subjects described it as helpful while the other half described it as not helpful. Positive responses about the helpfulness of embedded feedback were given by nearly all of the 9th-graders, two-thirds of the WW students, but only two 7th-graders. Specific comments suggested that the feedback helped in making editing changes on mechanics and, to a lesser extent, story strategies, clarity, and organization.

Teacher Interviews

Teacher interviews conveyed opinions about the hypertext environment that were similar to those of the students. Specifically, the computer teacher, like her 7th- and 9th-graders, was positive about hypertext writing and cited branching as one of the main reasons. The WW teacher, like her class, conveyed reserved feelings about hypertext and identified the small page size and technical difficulties as the main problems.

Both teachers indicated problems with the small writing space and with the fact that the writing process had to be monitored continually to move the cursor manually to new fields (a limitation of the interface). Thus, teachers' concerns were less with the features of the process writing model than with the ease of using the hypertext writing environment. Other identified problems were the requirement for students to work from back-up disks and the difficulty of generating print copies of stories because of the time required to print the writing story stacks. Operational factors associated with the technology over-shadowed the teachers' interest in the instructional implications of the model for process writing.

Hypertext Facilitation of the Process Model

Writing Samples Analysis

Analysis of the 47 randomly selected writing samples identified eight general categories of problems experienced in all grades. Frequencies and brief characterizations of the categories are summarized in Table 4 (for a more detailed description, see Lohr, 1993). The most common problems concerned the development of story structure and of appropriate details. Despite the problems detected by the analysis, only three students embedded comments (in the idea box or elsewhere) indicating personal awareness of difficulties. Further, there was no incidence of peer feedback, although students had been instructed to provide and obtain it.

Table 4
Categories of Problems Identified in Daily Collections of Randomly Selected Student Writing

Problem Category	Description	Frequency
Story Structure	Story had no conflict or resolution	11
Development of appropriate details	Details included either confused the reader or did not facilitate story development	7
Organization	Story is not focused. Too many characters introduced too quickly	4
Publishing	Inordinate attention to graphic quality over story content. One incident of student changing font to "Script" to maintain privacy.	4
Originality	Story is cliché or too similar to another story.	3
Expressing ideas	Superficial description	2
Getting ideas	Blank pages	2
Branching	Story is not enhanced by branches	2

Modeling

We predicted that students might model or mimic expert writing strategies observed from the teacher's writing from the embedded story, The Frog Princess or from observations of other students. Although some modeling was noted, it tended to be at a superficial level and did not appear to reflect specific writing strategies designed to improve story quality. Both teachers observed that modeling was mostly represented in imitating story themes that others had used.

Embedded Feedback Comments

To determine the nature of the feedback provided by teachers (f = 123) and students (f = 34), the feedback comments were analyzed for basic theme. Five categories emerged: (1) 72 comments about writing mechanics, (2) 35 comments of encouragement ("Keep up the good work"), (3) 25 comments on basic story writing strategies, (4) 17 comments on improving clarity or organization, and 8 comments (all from students) that were silly or entertaining. The WW teacher was responsible for 75% of the comments on mechanics, but only 8% of the encouraging comments; the computer teacher gave 22% and 35% of the comments in these respective categories.

Observer Impressions

A journal was kept by the first author while observing the five-week classroom implementation. Descriptions of the main highlights of the observations are reported in two sections: Introductory Lessons and the four weeks of story writing (for more detailed descriptions, see Lohr, 1993).

Introductory Lessons

Students in all classes completed the Introductory Lesson and the Frog Princess writing activities in four 50-minute sessions. Most of the problems encountered during this period concerned the interface. One problem was the need for the teacher to access each student's computer to check individual work, a time-consuming task. This was remedied by requiring students to save and submit their work on 3.5 in. back-up disks.

Overall, observations indicated that most students had little trouble learning to use the system. While nearly all were successful in writing endings to the Frog Princess, as a rule, the older the class, the less was written. The WW students, for example, often wrote endings consisting of only a few sentences, while 7th- and 9th-graders typically wrote several pages. Although students were reminded each day to read the appropriate mini-lessons, most seemed to ignore these aids.

Hypertext Story Writing

At the start of the four-week hypertext writing phase, qualitative differences across grade levels were immediately noticed. Within a few days, 7th-graders were focused on writing and only occasionally needed disciplinary reprimands. This self-directed behavior persisted for a majority throughout the four weeks. Frequently, 7th-graders stayed after class to complete their work and many made comments about their progress when they saw the teacher outside of class. The 7th-graders, however, were not very active in or successful at providing feedback and assistance to peers.

The high school students were more restless and more difficult to engage in the writing program. In direct contrast to the 7th-graders, these older students continually engaged in conferencing with others, so much so that the teacher eventually banned conferencing, feeling that such interactions were exploited too frequently for social exchanges. The 9th-graders were the only group to request working on stories in pairs. The teacher allowed this activity for one of the two stories. Its effectiveness was difficult to determine, although there was much talking between the students as they worked.

Teacher Behaviors

The computer teacher was clearly more positive about the hypertext writing environment than was the high school teacher. The former took a more open approach to the program, allowing rules to evolve as needed. She imposed few requirements on students, treating branching, for example, as an option rather than a necessary story feature. Rather than requiring students to write in a folk-tale adventure theme consistent with the Frog Princess, she felt that students should be able to choose their own theme and genre. The computer teacher was very communicative about her impressions and feelings. She made frequent comments that the writing environment was working well.

When the first author visited classes, the high school teacher rarely volunteered comments about the program and generally seemed somewhat negative in her attitudes toward the program both in class and in interviews. She set more rules than did the computer teacher, and displayed a strong commitment to monitoring adherence to the rules. Her basic rules, which promoted a relatively mechanized approach to process writing consisted of requiring 10-page stories, creating branches, and featuring a certain number of characters in the stories. She started every class by listing the rules and reminding students that their work would be graded. Compared to the computer teacher, she spent more time carefully reading students' stories and making comments about their construction and quality.

Problems

Throughout the hypertext writing experience, various problems occurred. Major types consisted of:

Limitations and "bugs": lack of spelling check, writing fields were too short, cut-and-paste tools could move only four lines.

Disk and computer failure: 3 out of 22 computers needed repair; 6 out of 37 floppy disks went bad (several students lost their only copies of work).

Interface: did not permit floppy disk backups to be made from files stored on the hard drive, did not show the date or time of last use on stored files, the system locked when disk became full.

Unplanned teacher activities: Too much time devoted to Story 1, leaving less time for Story 2; limited use of embedded comments; insistence on students' producing print copies of all work, which took considerable time due to graphics; failure to follow procedures of process writing; failure to require/encourage reading of the mini-lessons.

Discussion

Findings are discussed below in relation to the three major research questions.

Embedded Feature Use

Overall, most students felt that the embedded features (branching, goal/idea buttons, editor buttons, mini-lessons, and cut-and-paste) were easy to use. Their usage of those features, however, tended to be limited. Three reasons are suggested. The first was lack of classroom writing time. For example, when students were asked why they did not use the mini-lessons, a typical response was "deadlines/too busy."

A second probable reason was lack of familiarity with the process writing concept and procedures. Contrary to teacher claims, almost all students indicated that the hypertext experience was their first exposure to a process orientation. Most also indicated that they received more feedback in the hypertext writing program than in any other school writing experience.

A third probable reason for the low feature use was lack of metacognitive skills to assess learning needs. When learning tasks are difficult, as in the case in writing, which depends heavily on metacognitive skills (Brown, 1987), learners may select less instructional support to complete the task earlier or because they don't see its value (Ross & Morrison, 1989).

Problem-solving. There was little evidence that students capitalized on the hypertext embedded features to solve problems while writing. Specifically, few students used branching as a way to develop or explore different arguments in the form of alternative plots or story endings. Further, with the exception of several students in the WW class, little attention appeared to be given to problem-solving in general, a main component of process writing.

Expert modeling. Overall, modeling was limited in frequency and restricted to superficial features, such as story theme. Based on our observations and the interview responses, students apparently found it too time-consuming and difficult to try to model actual story writing strategies.

Non-linear recursive writing. Findings did support, at a relatively superficial level, facilitation by the embedded features of planning, revising, and editing components of non-linear writing. With regard to planning, students' embedded comments in idea/goal buttons tended to be summary descriptions of story content rather than insights into dilemmas or plans of the writer. The implication is that students may not have known how to proceed with communicating their ideas, or they may have lacked generation and development skills. According to Resnick (1987), problem-solving models often fail because students don't know how to apply the models in specific contexts.

The high school students made greater use of embedded feedback for revision than did 7th-graders. This result is not surprising, since the high school teacher used the feedback more for task-oriented guidance and correction, whereas the computer teacher used it more for reinforcement. Based on student reactions, the former type (academically-oriented) feedback was viewed as more valuable.

For all classes, none of the students' embedded comments offered help to others in story writing strategies. Some story-writing comments were made by the computer teacher and especially by the high school teacher. Again, the latter's expertise in composition appeared to be the critical factor.

As the above results convey, although the embedded features were logical instructional design components, they were not utilized as anticipated to support the process writing model. The mere packaging of powerful instructional strategies in technologically-sophisticated media presentations does not guarantee that such strategies will be accepted by teachers or learners. For example, in a study of student uses of data-bases, Neuman (1993) found that numerous inappropriate design features of the data-bases prohibited easy access to material and created resistance to using the database systems. Gallo and Horton (in press) found similar problems in teachers' usage of Internet for educational functions. For new media applications to be effective, the status and needs of learners (and their teachers) must be considered as strongly as the content design features (Jonassen, Campbell, & Davidson, 1994). Two important factors are therefore likely to be time for users to become familiar and experienced with the application and sufficient front-end and ongoing training to facilitate skill acquisition.

Writing Improvement

Moderate to low writing scores in the holistic evaluation indicated that, in spite of hypertext-based efforts to improve the more nebulous qualities of writing (e.g., complexity, organization, clarity, and style; see Hillerich, 1985), student writing in this study tended to reflect the types of problems suggested in prior research (Applebee et al., 1990;

McGee & Richels, 1990; Stein, 1987). Such problems included lack of complex plots or analyses of different points of view, use of stereotypical solutions, and limited use of planning and writing strategies.

Analyses of writing scores indicated that the quality of stories did not improve over time, as might be expected from an environment designed to facilitate the writing process. One consideration is the possible insensitivity of the writing assessment for detecting changes in quality over an eight-week time frame. Limited interventions, like the process strategies taught here, may provide useful orientations and beginning experiences that, with additional practice and "incubation" time, engender improved skills. Further research that evaluates the strategies over an extended time period is therefore suggested.

Gender and Class Differences

Generally, the present results revealed no reliable differences between male and female students in their usage of the system, attitudes, or performance. Class differences were more noticeable across the various outcome measures. Although the majority of students were positive about the writing environment, the WW students were consistently less so than the younger students. This outcome appears mostly attributable to two factors, the students' task goals and the teacher's attitudes.

For the WW students, the task goals were more directed toward learning to write than to increasing their experiences with technology. Technical problems, in addition to the small page size which limited writing space and speed, were considered hindrances to efficient composition. Further, the isolation of process model components into separate pop-up buttons and spaces may have inadvertently worked to make the writing process more linear rather than less so. By separating the writing space for goals and ideas, idea generation may have been forced out of its relevant or natural contexts. One 12th-grader, for example, indicated that preparing to record thoughts, rather than just writing the thoughts into his work, served to interrupt writing rather than facilitate it.

The more positive attitudes by the younger students seems to be at least partly attributable to visual features. Several students elaborated about the appeal of the "book-like" appearance and the small page size, which some of the WW students, in contrast, described as "babyish." It also seems important that the younger students had much less experience with word processing and, consequently, had fewer expectancies for features that increased convenience and efficiency.

The contrasting attitudes of the two teachers suggests the importance of social variables in the acceptance and implementation of technology, a major finding in word-processing research (Cochran-Smith, 1991). The high school teacher appeared to focus more on the appropriateness of the hypertext environment for production rather than for the development of writing skills. Accordingly, she viewed the system as less "convenient" than conventional word processing for creating and disseminating student work. This negative attitude toward the technical qualities of hypertext was mirrored by her students, an outcome similar to the one found by Bradley (1993) in her study of factors influencing student attitudes toward Channel One.

The computer teacher, in direct contrast, took great interest in the potential of hypertext to stimulate new, creative approaches to writing. She perceived the various embedded features as tools for exploring different approaches to writing rather than as impediments to efficient production of final drafts. As a result, her students appeared much more open to using the system, although, like the high school students, they quickly abandoned features that they found less relevant to their personal interests and objectives. The clear implication, however, is that for technology to have an impact on classroom instruction, teachers must view the new systems as beneficial, be invested in their application, and be sufficiently trained in their use (Gallo & Horton, in press; also see Garland, 1991). In the present study, what was thought to be reasonable time working with teachers was apparently insufficient for achieving these skills and dispositions.

Recommendations

While technological problems may reduce the success of new computer-based instructional strategies, factors intrinsic to the subject area or strategies themselves may prove just as limiting. In this regard, barriers to the success of the present hypertext environment proved to be problems intrinsic to process writing instruction, as identified in the literature (Applebee et al., 1990; Calkins, 1986; Stein, 1987). Students were unfamiliar with the process orientation, the instruction provided by teachers was superficial, and students' story writing skills were generally poor. While the various support features (idea buttons, editor buttons, branching, etc.) were consistent with process writing strategies, technical problems and teacher inexperience limited their utility. Based on the results, some suggestions for future instructional design in this area are offered below.

As stated by Jones, Li, and Merrill (1992), HyperCard is a type of rapid prototype model designed more for programmers than for designers. Other, more customized prototypes may represent more convenient models because they consist of components related to instructional design needs, and are therefore not only easier to assemble quickly, but address the needs of the content more efficiently. Thus, while the hypertext environment presents new possibilities for creative, non-linear story writing, its lack of adaptive features for supporting such writing applications leads to the typical problems that occur when instruction is driven by the available technology rather than by the needs of the learner (Davies, 1993; Newman, 1993). Since the HyperCard environment had limited text editing procedures, it was not feasible to revise the stack and conduct further testing to refine the product as recommended by Dick & Carey (1991). Ideally, we would have proceeded to the development of an application to address these shortcomings with a more powerful development environment. This development effort, however, was beyond the scope of this project.

In the present study, two major categories of problems related to operational difficulties and weaknesses in the instructional design. It would should also be noted that, even though Stage 1 and Stage 2 of the evaluation model were not as rigorous as their counterparts in the Dick and Carey (1991) formative model, these phases were unlikely to identify many of the problems that actually emerged when the hypertext instructional program was actually integrated with teacher instruction, class goals, and other school or class activities. Possible improvements for process writing applications are suggested below.

1. Make the system operate more like a word processor, to include spell checking, more space for cut-and-paste, and repositioning of the cursor at the end of a page.
2. Improve the security interface (At Ease) to allow for easier file management and protection of individual files.
3. Allow for networking arrangements to facilitate communication exchanges and file access between students and the teacher.
4. Give teachers more control over the writing environment by either requiring students to read the mini-lessons or teaching the declarative and procedural knowledge via other instructional methods. As students gain more experience and demonstrate mastery of process writing skills, they should be given more freedom to experiment freely, even by creating multiple levels of branches. This recommendation of graduated learner-control allowances is consistent with conclusions from other learner-control studies (Ross & Morrison, 1989; Tennyson, 1981).
5. Program the hypertext environment to require students to complete certain units or master certain skills before they are allowed access to certain features. Additional programming might also be used to provide teachers, for monitoring purposes, descriptive summaries of student feature uses and writing activities.
6. Explore means of using branching more effectively. Branching was the most popular program component and the one most frequently cited by students in discussing idea generation and development. Branching also appears a highly appropriate format for introducing complexity and using critical thinking skills in writing (see Resnick, 1987). A possible refinement of the present instructional strategy would be to include more direct teaching and modeling (through story samples) of effective branching strategies.
7. Give more attention to developing teacher expertise and interest in using the hypertext system.

Of all the variables investigated in this study, most critical to the success of the hypertext writing environment appeared to be those relating to teacher and student perceptions of its efficiency. The results also support general findings of other research, which identify the highly influential role of classroom social systems on the success of any new technology (Cochran-Smith, 1991; Reilly, 1992). The implication is that it makes little sense to overlay such technologies on existing instructional systems and expect immediate acceptance and operational efficiency. The continuing challenge for instructional designers is effectively integrating the new delivery strategies to fit classroom conditions and curriculum needs. As demonstrated in this research, systematic evaluation can provide a valuable tool for facilitating this integration over time.

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Title:

A Case Study of Instructional Design Practices: Implications for Instructional Designers

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Abstract

High tech organizations such as Storage Technology Corporation (STK) are increasingly under pressure to both reduce cycle time in bringing newer technologies to an international market place and produce timely and effective instruction. Traditional cascaded Instructinal Systems Design Models (ISD), assumed to be in common practise are used as processes at STK. A survey was distributed to determine which steps are followed in an ISD model and why certain steps are ommitted. Inquiry findings indicate that the models are not followed because employees do not understand all the steps, do not have the time to complete them, or decisions have been preempted prior to the project getting to the instructional designer. The ability of ISD models to meet instructional designer needs is discussed in light of the inquiry.

Introduction

Current Instructional Design Models, defined here as: traditional cascaded models (Fig. 1), relying on formal rules and linear steps, are assumed to be commonly applied in corporate educational departments (Hannum & Hansen, 1989). Proponents of these models, such as Hannum & Hansen, Dick and Carey, and others, have adapted a systems approach to instructional design. The outcome of this adaptation posits an increasing use of formal instructional systems design (ISD) models in corporations (Hannum & Hansen, 1989).

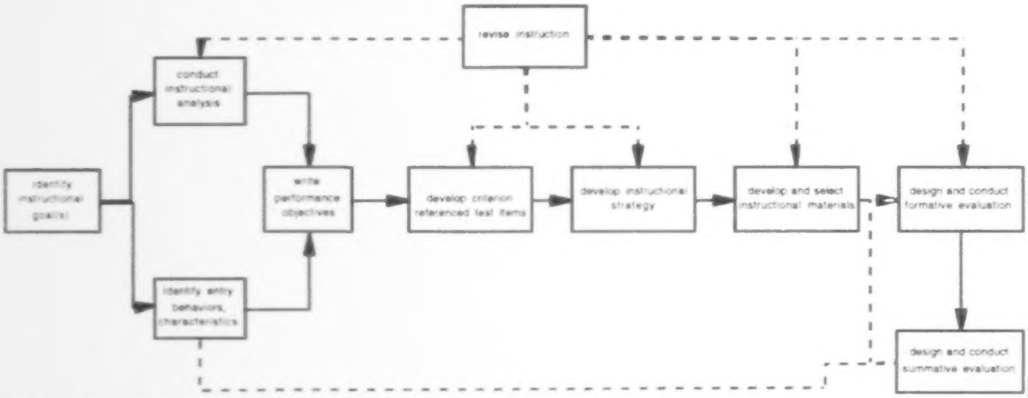
revise instruction
conduct instructional analysis
identify instructional goal(s)
write performance objectives
develop criterion referenced test items
develop instructional strategy
develop and select instructional materials
design and conduct formative evaluation
identify entry behaviors, characteristics
design and conduct summative evaluation

Figure 7 The Dick & Carey ISD Model

The role of technology in the corporate world

Technology in the corporate world continues at an unprecendented expansion since ISD models came into widespread use. Along with technological advancement, there exists a coevolving use of technological tools designed to facilitate use of the new technologies. Today's corporation presents us with unprecedented complexity. Such complexity produces a need to provide timely training, not only of the technologies themselves, but also of the tools which provide access to using the technologies.

The effects of technological change spill over to corporations which may not necessarily think of themselves as "technology-based." Examples extend to workers needing to learn new phone systems, email, word processing, data bases, and a myriad of other technological tools which permeate the modern corporation.

Cross-domain knowledge thus becomes an essential component for workers. They must not only cope with the need to understand their primary job function, but also must acquire whatever corollary knowledge of tools deemed necessary to "do their job."

While rapid enhancements in a wide range of technologies drive rapid turnover of new products, they also create an easily reached global marketplace. The global marketplace increases competition and subsequently generates a need to reduce cycle time for new product development. Reduction of cycle time extends to include instruction and training. The challenge of producing effective instruction, on a timely basis by corporate education departments, increases proportionately with the technological change. An ever more rapid cycle of new product development drags with it a need for timely new product training.

The influence of standards criteria

By the year 1995, the European Union (EU) imposed the requirement of meeting ISO 9000 Standards as a prerequisite for conducting business within its member countries. ISO 9000 standards brought Total Quality Management (TQM) to all corporations conducting business with the EU. Therefore, ISO 9000 standards provided a measurable standard of quality for any corporation doing business with the EU. Corporations needed "certification" by an independent agency, which stated the corporation met the standards. These independent agencies conduct yearly audits of certified corporations, ensuring continued compliance with the ISO 9000 standards.

A great deal of time and effort has been put forth by multinational corporations to comply with the standards. A component of the standards is, "...quality education and training" (Scherkenbach, 1990). In effect, corporations must not only have education plans in place for their employees, but must also comply with a rigid process for the design, development, and delivery of such education. On the surface, ISD models seem to represent the perfect marriage of meeting ISO standards and producing effective instruction.

Problem definition

Given the need to "reduce cycle time" while at the same time cleaving to ISO 9000 standards, how do corporate education departments fare in producing quality as well as timely instruction?

Research Question

Before a measurement of how well do corporate education departments meet the needs of their customers can be made, a research question centering around how the departments go about producing instruction must be answered. The primary motivation for this study at Storage Technology Corporation becomes, "How does the process of instructional systems design proceed at Storage Technology Corporation (STK)?"

Prior studies

The theoretical grounding which underlies this inquiry concerns accepted instructional design models such as those of Dick and Carey (1990). These models have long-standing application in both industry and in the military. Recent publications (Wedman & Tessmer, 1990 and Edmonds, Branch & Mukerjee, 1994) have sought to address the inadequacy of traditional design models.

A number of authors have recognized the limitations of ISD models in fast-paced environments, or environments where cultural factors interject themselves in the design process. Wedman and Tessmer (1990) describe the potential for erosion of educational quality by haphazardly omitting steps from a design model. They propose a "layers of necessity" model which offers a set of heuristics by which steps can be omitted without completely destroying the quality of the instruction.

Edmunds, Branch and Mukerjee (1994) offer a framework for comparison of different instructional design models, with the idea of choosing a model which "best fits" the situation. Their comparison framework of the different models currently in use permits a reasonable assessment of which models to use for differing design needs, and a measure of the model's chance for being reliably successful, given different types of instruction (classroom focused, product focused, system focused).

Rowland (1992) attempted a definition how "expert" instructional designers and "novice" instructional designers approached the solution of an instructional problem. Large differences in approaches to instructional design problem solving emerged. Significantly, experts formed "mental models" and looked for causal relationships and deep system understanding. They formulated solutions to different links within the problem, and adopted a variety of possibilities for those solutions. Their problem interpretation was categorized as ill-defined, in that they were rather flexible in adopting and discarding multiple solutions. In all cases they used lengthy analysis, multiplicity, and variety.

The above approach sharply contrasted to novices, who "believed" the information they were given and performed shallow analyses and referring to the problem information that was given them at frequent intervals.

The basic premise put forth by Wedman and Tessmer (1994) is that, "Design models are based on assumptions which are incompatible with practice." Wedman and Tessmer suggest the incompatibility exists because the design models do not permit "selective" exclusion of particular steps.

Since in their study steps were clearly omitted, then quality of instruction could be eroded due to the lack of any prescribed and analytical way to exclude such steps. Their study surveyed 73 training professionals involved in instructional design. The survey was a two part survey. The first part of the survey asked the frequency with which the subjects completed eleven steps in the ID model which are traditionally thought of as critical to the process. The second part requested the subjects to give reasons why a particular design activity was excluded.

The implication of Wedman's & Tessmer's, and Rowland's findings for the case of multinational corporations lies within the notion that the bulk of their technical trainers come from a technical background, with little or no background in instructional design

The question must be raised, "Does instructional design from such persons suffer from their lack of understanding of the process of ISD?" From this question the assumption that instructional design models are indeed followed during the production of instruction, needs a comprehensive evaluation, given the current corporate environment, with its cycles of technological change, requirements to reduce cycle time, and pressures of global competition.

Method

Storage Technology Corporation target population

Storage Technology Corporation (STK) is a producer of hardware and software within the mainframe, mid-range (small mainframes), and open systems (networked) markets. They are currently positioning themselves to enter the open systems market to a greater extent. STK is a multinational corporation, which does some 40% of its business in foreign markets. As such it fits the framework outlined above and is ISO 9000 certified. The major products STK has historically excelled in have been storage related, comprised mainly of high speed tape, and solid state storage systems in the terrabyte range and attached to large main frame computing environments.

Spheres of responsibility within STK Headquarters Corporate Education comprise five subsets, plus adjunct positions directly under the Director of Corporate Education. The five subsets follow:

- Training Technology (Multimedia)
- Hardware Education
- Software and Marketing Education
- Headquarters Education
- Leadership and Quality Education

Each department within Corporate Education encompasses different arenas of instruction. In addition there are satellite regional education offices within the US and other countries. As a result one of Corporate Education's functions is that of "train the trainer," i.e. to teach those who return to their respective locations to teach.

Subjects

A total of 67 subjects were included in the inquiry. Baseline information about these subjects is limited and currently generalizable to stating that they have diverse education and backgrounds, regarding both ISD and their subject content areas. Job responsibilities seem to reflect this diversity, ranging from being involved in the entire process of ISD, plus delivery (teaching), to being involved in just a few of the component steps, i.e. just delivery or just the design phase, or development phase. For the purpose of this study, delivery will be included in the ISD process.

Instrument

The inquiry utilized a survey adapted from Wedman & Tessmer (1994) which was based on Dick's and Carey's (1990) ISD model. The survey probed which ISD activities get completed, which activities are omitted, and why the activities are omitted. The activities covered the same territory as Wedman and Tessmer (1993) and are outlined below:

- conduct a needs assessment
- training is the solution
- conduct a task analysis
- write learning objectives
- identify learning outcomes
- assess student entry level skills
- develop test items
- select instructional strategies
- select media formats
- pilot test instructions
- do formative evaluation

Frequency of inclusion in the ISD process again followed Wedman and Tessmer and was expressed as, *Not applicable (NA), Always, Usually, Occasionally, Never*. In addition we asked if there were design activities which the respondents did which were not addressed in the survey.

A second part of the survey listed reasons which were germane at STK about why certain activities were not completed. They are listed below:

- not perceived as applicable (NA)
- lack expertise
- decision already made
- unnecessary
- no time
- no money
- customer will not permit inclusion
- restriction on travel
- no process in place

A third portion probed respondents background, including their education in ISD, their education for the content area within which they produce instruction, their experience with ISD, any prior experience or formal instruction in teaching. In addition there were open-ended portions which probed perceived problems with STK's apprach to ISD and solicited input as to how to change direction.

Baseline information therefore, addressed what combinations of instructional design experience and education in instructional design the respondents bring to the department. It also addresses what subject matter expertise respondents bring to their design activities.

Analysis

There were a total of 46 persons who responded to the survey (69%). Of the 46, 8 (17%) had formal university level courses in instructional design. Only 4 (9%) had a degree or a major area of study in instructional design. 18 or 39% had graduate degrees, 16 or 35% had undergraduate degrees, 2 or 4% had associate degrees and 6 or 13% had high scool diplpomas. The group with the lowest number of degreed personnel were in the hardware education group (31%), the highest number were in the software engineering group (100%).

Table 1: numbers and percentages of respondents with ID course work

Ed Departments @stk	**Number & percentage of respondents with IT course work**
Training & Technology Group	4 57%
Hardware Education	2 14%
Software & Marketing	1 16%
Leadership & Quality Education	2 40%
Headqarters Education	2 11%
Management	1 33%

It should be noted that the above percentages of individuals with IT course work would drop if those who did not respond to the questionnaire had done so (informal conversation with members of the department). The above table also refers to prsons who have had course work in IT. The number of persons holding degrees in IT at STK Corporate Education is actually four.

Results

Table 2 Percentage of design activities completed by the respondents

Activity	**always**	**usually**	**occasionally**	**never**
conduct needs assessment	27%	39%	24%	9%
training is the solution	12%	51%	9%	28%
conduct a task analysis	42%	27%	27%	4%
write learning objectives	66%	33%	0%	1%
identify learning outcomes	27%	36%	15%	12%
assess entry level skills	19%	22%	36%	22%
develop test items	4%	33%	39%	24%
select instructional strategies	27%	33%	33%	7%
select media formats	26%	26%	36%	12%
pilot test instructions	44%	15%	29%	12%
conduct form-ative evals.	25%	30%	30%	15%

The above results loosely follow those of Wedman and Tessmer (1993), however, followup discussions with respondents revealed misconceptions about design activities. An example: Persons involved in teaching long term coureses mistook normal course maintenance, the process of adding new information to a course and deleting outdated information, with formative evaluation.

No respondent stated they completed all the design activities 100% of the time, and only one respondent stated they "usually + always" completed design activities.

Of the activities most frequently accomplished writing learning objectives was most often completed, followed by piloting test instructions. Writing learning objectives was the only activity identified as being always done by more than half of the respondents.

Why activities get excluded

Table 3 Reasons for exclusing ID activity

Activity	**NA**	**Lack expertise**	**Client non-support**	**Decision already made**
needs assessment	6	3	5	21
Training as solution	5		2	23
Conduct a task analysis	4	5	4	12
Write learning objectives	7	4	1	5
Identify learning outcomes	5	6		1
Assess entry level skills	2	3	2	8
Develop test items	6	3	1	4
Select instructional strategies	4	5	1	11
Pilot test instructions	8	3		1
Conduct formative evaluation	5	1	3	2

Table 3: continued

Activity	**Unnessary**	**No time**	**No money**	**Travel restrictions**	**process not in place**
needs assessment	4	9	4	2	5
Training as solution	1	1		2	1
task analysis		6	2	1	2
Learning objectives	1	1		1	1
Learning outcomes				1	4
Assess entry level skills	3	7	2	4	7
Develop test items	4	2			3
Select instructional strategies		2			2
select media formats	1	1	3		
pilot test instructions	1	7	1	2	2
conduct formative evaluations		10	6	2	8

The client non-support category was excluded fromt the above table because it was not regarded more than three timnes as a limitation on design activities.

The most common reason for the exclusion of design activities was the decision had already been made prior to the designer getting the project. The categories where this reason is most evident are conducting needs assessment, identifying training as the solution to the instructional problem, and conducting a task analysis.

Discussion

The results of the survey indicate that not all design activities are done for all projects. In the above cases, the reasons for the decision already being made can be loosely grouped into the category of "corporate culture." Decisions about what projects were to be taken on as instructional projects were generated largely through a corporate Program Management Process(PMP) which has as a requirement a preliminary education plan prior to the product's going through a gated process (in this case an idea gate.) The preliminary plan is supposed to be generated by a responsible manager.

No manager involved with this study took a formal part in any design team. Only one filled in the questionnaire but qualified the answers by saying, "from the time I was an education specilaist." Other management people responded by stating the questionnaire was not germane to them. One can conclude from the survey that determination of activities to include for any given project are largely predetermined.

Partly the above conclusion derives from lack of knowledge on the part of both management and employee of ISD. Historically, STK has approached instructional problems from the same base, i.e. STK has always implemented new product training so a lecture/lab course is an expectation of the corporation for any new product. There is both a knowledge gap and cultural impediment to following the ISD process at STK.

Conclusions

Steps are ommitted from ISD because they either are predetermined (decision already made) or they are largely misunderstood by those trying to implement them. As in Wedman and Tessmers' (1993), ISD practise is a situational activity at STK. The value of the ISD model must also be questioned. Clearly the corporation doesn't hire personnel based on their education in ISD, but rather for their skill in a specific content area. Knowledge of ISD is a supplementary skill.

The result of the study points to the conclusion that traditional ISD models, after which STK processes are patterned, are not followed, and therefore not of value to the corporation other than to satisfy a need to implement a standard for doing business. STK doesn't generally hire people with that knowledge, therefore the model should be discarded at STK and replaced with a more useable way of producing timely and effective instruction or instructional alternatives when called for.

Implications for practicing Instructional Designers

A high tech corporation such as STK values subject area knowledge more than ISD knowledge. This points to a possible dichotomy in the future of the field. Since the corporation is reluctant to hire people with strictly ISD background, such persons might be better suited to consulting. What STK values is content knowledge. Engineering managers are reluctant to offer engineers as subject matter experts, therfore engineering knowledge becomes a valued commodity.

Areas for further study

The question of whether STK follows a typical pattern for technical corporations might provide a fertile area for further research. Anecdotal information on two like corporations, HP and Sun indicates their technical training departments perform other functions, such as consulting and product support. Furthermore they often outsource soft skill components of training.

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Title:

MIDI Keyboards: Memory Skills and Building Values toward School

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Problem

MIDI keyboards are being introduced in school curricula. Their effects beyond music instruction are not known.

Questions

a. Does school instruction in MIDI keyboards improve memory skills?
b. Does school instruction in MIDI keyboards improve sentiment toward school?

Participants

Pupils in early elementary grade at five schools were evaluated. The pupils and the schools differed demographically. School 1 was in a poor, urban center. All the pupils were black African-Americans. School 2 was in a different poor urban center. The group of pupils was nearly evenly split racially between black and white. The third school was in a middle-class suburb. Nearly all of the pupils were white. The fourth and fifth schools were in the same large semi-rural school district. All of the children were black. The latter two schools were compared and those results are reported.

Variables

Memory skills and sentiment towards school were measured since these variables represented areas that were fundamental to learning and were therefore relevant for cross-curricular education and because of the likelihood that keyboard instruction could contribute to their development.

Instruments

Two assessment instruments were used. Subtests of the Wide Range Assessment of Memory Learning (WRAML) by Sheslow and Adams (1990) measured memory skills. A School Sentiment Inventory was a survey developed to gauge sentiment towards school and instructional media including the keyboard.

Procedures

Pupils were interviewed at the beginning and end of a school year for both measures. During the year comparison groups were provided regularly-scheduled music instruction for one half-hour per week with the same instructor.

Analysis

Interview scores were compared for each group for the beginning and end of the school year. Scores were also compared between groups for both periods.

Results

There were no discernible gains in memory skills that were clearly attributable to keyboard instruction.

Overall, the various analyses of school sentiment data favorably support the groups that conducted music instruction with keyboards.

Discussion

The School Sentiment Inventory results were encouraging regarding the integration of piano keyboards into an elementary school curriculum. We surmise that the pupils' achieving competence in keyboard instruction contributed to their approval ratings of school and music instruction. The sentiment underlying the ratings may develop a value for keyboard instruction that may transfer to other learning or school work.

The lack of differences in terms of affecting memory skills can perhaps be explained by the fact that the pupils were engaged in about thirty minutes of music instruction per week. It is unlikely that this was enough time to develop memory skills that were observable beyond music performance. At the same time, the favorable sentiment towards music and school can be attributed to this short amount of instructional time.

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Title:

Motivation and Teachers' Computer Use

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Abstract

Four studies were conducted, two with independent groups of practicing teachers and two conducted longitudinally, once with a single group as preservice undergraduate teachers, and again subsequently after they had taught professionally for a year. A purpose of these studies was to identify levels of computer use among practicing teachers and change from expected to actual levels of use among the preservice-to-novice group. Another purpose was to identify variables of internal motivation as predictors of teachers' computer use. Levels of computer use among teachers were not high. Preservice students' expectations of computer use were very high then dropped after one year of professional teaching. Perceived relevance of and self-competence in computer use were predictors; when subjective norms was included in the calculation it emerged as the sole predictor.

Introduction

Underutilization of computers for teaching has occurred in spite of two prevailing conditions that would seem to promote their use. First, there is much support for the opinion that educational computer technology could significantly improve the educational system (National Task Force on Educational Technology, 1986; Shanker, 1990; Sheingold & Hadley, 1990; United States Office of Technology Assessment [OTA], 1988). Secondly, the microintensity level—ratio of computers per learner has improved from 112.4:1 in 1983 to 18.9:1 in 1992 (OTA, 1988; Market Data Retrieval, 1992). Yet, despite increased availability and support for computers, relatively few teachers have integrated them into their teaching. A survey of teachers who were exceptional users of computers for teaching averaged only about one such teacher per school (Sheingold & Hadley, 1990). This paucity of integration occurred even though the availability of computers (59) in the schools surveyed was more than double the average number of computers (26) available for schools in the United States (Becker, 1989). Extraordinary abundance of computers was not matched by an abundance of extraordinary users of computers. The result of this imbalance is that computers are underutilized.

These studies were undertaken to identify what teacher variables might predict computer use. First, computer use was classified as a process of the adoption of innovation (Hall, 1982; Rogers 1962, 1983; Rogers & Shoemaker, 1971) or more specifically Instructional Transformation (Hooper & Rieber, 1995; Rieber & Welliver, 1989; Welliver, 1990).

Secondly, teachers' computer use was examined for the influence of personal variables to computer use. In a broad study of the implementation of innovation in education, this class of variables was excluded (Berman & McLaughlin, 1978). Yet, information about personal variables may be the most valuable for influencing behavior or performance (Coovert & Goldstein, 1980; Gallo, 1986; Jorde-Bloom & Ford, 1988). Sheingold and Hadley's survey (1990) suggested that teachers who were exceptional users of computers for teaching were also highly motivated. Because of the prominence of motivation as a personal variable relative to computer use, it was the focus of the studies. From within the broad construct of motivation, Expectancy Theory (Vroom, 1964) and subjective norms guided the selection of variables (Ajzen & Fishbein, 1980; Fishbein, Jaccard, Davidson, Ajzen, & Loken 1980)

Problem

Expectations for teachers to integrate educational computing into teaching are high. Levels of integration among teachers are low. Educational computing is underutilized.

Questions

1. What are the levels of computer use among teachers?
2. What are the changes from student-teachers expectations of computer use after one year of professional teaching?
3. What internal motivating variables predict computer use by teachers?

Participants/4 Studies

Four studies were conducted: two independent groups of practicing teachers and group studied twice longitudinally. The latter group first participated as undergraduate preservice teachers. Then, they participated after one year of professional teaching. Participants with an elementary school focus were selected to control for the prevalence of computer use in certain subjects as might be the case with secondary or post-secondary teachers.

Longitudinal Studies
a. Preservice undergraduates (*n* = 167)
b. Novice teachers (same as group 'a' but after 1 year of teaching) (*n* = 100)

Independent Studies
a. Practicing teachers (*n* = 170)
b. Practicing teachers (*n* = 138)

Variables

Criterion
- Levels of Computer Use

Independent
- Subjective norms (only for the last study)
- perceived relevance of computers
- self-competence in using computers
- innovativeness
- teacher locus of control

Demographics
- age
- gender
- computer experience

Instruments

a. Levels of Computer Use scale (LCU) (Marcinkiewicz & Welliver, 1993)
b. subjective norms scale (Fishbein, Jaccard, Davidson, Ajzen, I., & Loken, 1980; MacDonald, 1991; Marcinkiewicz, 1994)
c. survey for perceived relevance and self-competence
d. Innovativeness Scale (Hurt, Joseph, & Cook, 1977)
e. Teacher Locus of Control (Rose & Medway, 1981, 1982); Teacher Role Survey (Maes & Anderson, 1985)

Procedures

Participants completed questionnaires composed of the above measures. The instructions for the questionnaire for the preservice undergraduates were worded to elicit their expectations. The preservice sample was also split in its use of the two locus of control measures. Scores were then standardized as T scores.

Analysis

Levels of use were scored with the LCU scale. Exploratory intercorrelations were calculated. Logistic regressions were calculated to determine the predictor variables.

Results

For all studies, perceived relevance, self-competence, and innovativeness were correlated; however, for the study with the novice teachers the correlation between self-competence and perceived relevance was double that of previously scored.

The variables that were identified as predictors are listed in Table 2. The chronological order in which the studies were conducted is listed in Table 2 from left to right. The only variable in the last study conducted that was identified as contributing to the prediction of teachers' computer use was subjective norms.

Table 1

Levels of Computer Use

	Practicing 1	Practicing 2	Avg. % of Practicing	Preservice	Novice
Computer Use					
Nonuse	43.5	31.0	37.2	2.7	39
Utilization	48.5	66.0	57.2	84.0	60
Integration	8.0	3.0	5.5	13.3	1

Table 2

Predictors of Computer Use

	Practicing 1	Preservice	Novice	Practicing 2
self-competence	$p < .000$	$p < .04$	N	N
perceived relevance	N	$p < .005$	N	N
innovativeness	$p < .24$	N	N	N
teacher locus of control	N	N	$p < .03$*	N
subjective norms	X	X	X	$p < .01$

* Teacher Locus of Control for Preservice predicted Novices use.
X Subjective norms was not included in these studies.
N No Significant Difference

Discussion

In comparison with the expectations of the preservice teachers, the levels of computer use of among practicing teachers is low. However, while the preservice teachers had very high expectations of computer use, after they had taught for a year their levels of use approached the average levels of use of the practicing teachers. This may be attributable to regression to the mean behavior, ambitious undergraduate expectations, or the effects of an excellent undergraduate program. Still, the differences in use between the two groups were statistically significant.

For all the studies except for the Novice round of the longitudinal one, there is a pattern from among the personal variables that predict computer use. Self-competence and perceived relevance are highly correlated. This correlation is most dramatic between rounds 1 and 2 of the longitudinal study when the correlations nearly double in strength. Self-competence emerges as a predictor more often than do perceived relevance and innovativeness but since they are also correlated in different studies, it may be that together they are indicators of motivation to computer use. The necessity of feeling competent in the use of computer technology is intuitively appealing and is also predicted by expectancy theory. The increased strength of correlation between self-competence and perceived relevance during the Novice Study suggests the importance of these variables; their failure to predict computer use may be due to the increase in nonuse since the first round. Perhaps most compelling is the emergence of subjective norms as a predictor superior to either of the previously identified ones. While subjective norms reflects one's personal motivation it also reflects motivation based on one's perceptions of others' expectations—akin to phenomena such as peer pressure, introjected regulation, or values building. This result is consistent with the view that the expectations of a teacher's culture as embodied in one's administrators, colleagues, students and professional societies significantly influence a teacher to use computers.

Availability

The availability of computers is sometimes suggested as a factor in determining teachers use. These studies focused on personal motivation. It is important to consider availability and motivation as complementary and not as mutually exclusive. A model for competent human behavior was suggested by Gilbert (1978) in which the three dimensions of information, motivation, and equipment are crossed with external and internal perspectives. Gilbert's model provides a context which encompasses the need for the availability of computer equipment; it also acknowledges motivation. In sum, teachers will not adopt computers unless all dimensions are satisfied. When considering the dimension of motivation, subjective norms is predictive of teachers computer use.

Implications

In order for teachers to adopt computers, there needs to be a perception generated by the professional environment that computer integration is expected. This can be established by modeling use by administrators, colleagues, students, and the profession. A work environment would be equipped and faculty training and support would also be available.

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Title:

Lessons Learned from the Florida Teletraining Project

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Introduction

Communication technologies now exist to present live interactive instruction in real time via distance learning. Video Teletraining (VTT), also known as interactive television, is an application of distance education presented by a two-way audio and two-way video system. The major advantage of VTT is that it offers *live* instruction. While other technologies may be both viable and cost effective, the option of live instruction available through VTT may outweigh other distance learning strategies. Using a myriad of media--print, audio, video, computers, supplemental technologies-(e.g., the telephone and facsimile machine), and off-line equipment (e.g., videotape players)--provides instructors and students with a means for communicating and learning that may be almost as good as being there.

The Florida Teletraining Project (FTP) was funded by the Department of Defense to test the feasibility of using a video teletraining network (VTT) (two-way audio/two way compressed video) to present military instruction to reservists in Florida. This program was to be conducted by two-year community colleges in collaboration with armed forces schools, in part to test the capability of the community colleges to provide VTT instruction to reservists.

Objectives

The FTP was directed to identify, collect, and evaluate telecommunications and pilot project test data. The specific project objectives were to:

ascertain the merit of using telecommunications training provided by non-military sources (i.e., community colleges) for training military personnel

quantify the value of the instruction received

guide future government and DoD decisions related to distance learning.

Twenty-one evaluation objectives were identified for the project in the following categories: technology, instruction, community colleges, and cost. Data related to each of the objectives was collected from: (a) students, (b) course developers who were also the VTT instructors, (c) all remote site personnel including Instructional Coordinators (ICs), Points of Contact (POCs), and technicians, (d) administrative project staff at the origination site, (e) technical and production teams, and (f) military personnel including subject matter experts (SMEs), on-camera military instructors, and military remote site personnel.

These evaluation objectives focused on the:

technology selected for the project (e.g., ascertaining its reliability, the target community's acceptance of it, and how appropriate it was for providing the training)

instruction (e.g., determining whether or not the students met the learning objectives, and the effectiveness of the instructional strategies)

community college (e.g., roles and responsibilities as providers of military instruction)

costs (e.g., developing a cost model, determining the cost of course design and implementation, estimating the cost of an operational system, and comparing the cost of a telecommunications approach to the cost of selected conventional training options).

Video Teletraining in the Military

Dwindling resources and the size and importance of the reserve component are two of the main reasons the U.S. military has become interested in distance education. Specifically, reservist must be trained to the same standard as the active forces but they cannot be trained on a daily basis. This need for increased training has prompted the military services, industry, and academia to conduct research on the feasibility of training in a distance mode. While the research is in its infancy and many of the studies have limitations, researchers have drawn two primary conclusions: (a) students typically do as well on learning outcomes using distance education methods as they do when taught by conventional methods, and (b) student satisfaction using distance education is equal to or higher than classroom instruction (DeLoughry, 1988; Fahl, 1983; Grimes, Neilsen, & Niss, 1988; Keene & Cary, 1990; Kruh, 1983; Partin & Atkins, 1984).

The U.S. Army Training and Doctrine Command (TRADOC)(1987; 1990; 1991) supports the use of VTT and maintains that it is both an effective and cost efficient method for presenting instruction to RC forces. The Naval Air Warfare Center, Training Systems Division (NAWCTSD) has also conducted a series of studies that addressed different aspects of VTT. They too have concluded that VTT was a viable alternative for providing high quality and cost effective instruction to distance learners.

The need to find cost effective and efficient learning strategies has led to conclusions about what technologies are viable and effective, what courses should be selected for distance education, and what variables are key when designing distance learning courses. The NAWCTSD developed a course selection model for Navy VTT. The major recommendations from this study were: (a) select courses that have a high potential for savings, e.g., courses with high throughput and short duration, (b) select courses that have an appropriate mix of lecture and laboratory, (c) do not select courses that are equipment intensive, and (d) do not select courses that require substantial curriculum modification.

Course Design Considerations

Studies conducted by the Army and the Navy have concluded that distance education courses typically require more extensive planning than platform instruction. Haarland and Newby (1984) state that the increases in student performance and satisfaction may be due to improved course design and teaching performance rather than as a function of a specific technology. TRADOC endorses the SAT model for the design of courses and states that effective course delivery must take into account proper management of the design, resourcing, development, production, distribution, and evaluation of VTT programs.

At the core of interactive television is the concept of interactivity (Moore, 1989; Ritchie & Newby, 1989; Stoffel, 1987). Interactive television is defined by the fact that good instruction, whether it is presented in a classroom or at a distance, stresses interaction among the participants in the teaching-learning process.

In addition to interactivity, the following course design features are also necessary for successful VTT (Bailey, et al., 1989; Cyrs and Smith, 1990; Defense Language Institute, 1992; McDonald, et al., 1990; Martin, 1993; Ostendorf, 1991; Sheppard, et al., 1990):

group dynamics should be addressed

student involvement activities need to be carefully structured

lecture segments should not exceed 20 minutes

visual aids must be adapted for television viewing

careful planning is required to handle student questions and discussions

instructors must involve and motivate learners

an interactive study guide (ISG) must be provided

Because military projects are often large, management issues when using VTT are of utmost importance. Maloy and Perry (1991) addressed the policy and management issues of a large Navy project. They found that a large teletraining project required a team approach. Some of the key team members were an educational specialist (e.g., an instructional designer or evaluation expert), an engineer, a budget analyst, an audio-visual specialist, a security specialist,

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a researcher/analyst, a resource sponsor specialist (to provide support at the highest level), and representatives from civilian personnel, fleets, training command, and reserves.

In summary, effective teletraining courses are similar to other effective distance education programs. The following are key recommendations for successful VTT courses:

Select courses that are cognitive rather than psychomotor and that have high demand.

Course design and development is a critical component of a successful VTT course. Typically VTT courses require more detailed pre-planning than traditional courses. Time and resources must be allocated to the pre-planning stages.

Courses must be designed to facilitate interaction, to provide feedback, to be motivating, and to humanize the instruction. Course developers must be knowledgeable in the principles of learning and instruction.

Instructional personnel are one of the most important aspects of a VTT course. They may require considerable training and practice to be effective.

It takes a team of people to design and deliver good VTT instruction. This team must be organized and the roles and responsibilities of all personnel must be delineated.

Equipment failures occur. Contingency plans must be prepared. These plans may require the expenditure of additional time and resources.

In large scale projects, all the various management and organization functions need to be coordinated. Someone who is knowledgeable in all aspects of VTT needs to maintain a big picture perspective.

Overview of the Florida Teletraining Project

Five courses were reconfigured for delivery on the U.S. Army Teletraining Network, TNET. Three U.S. Army Reserve Component Configured Courseware (RC^3) Military Occupational Specialty (MOS) courses and two Navy special topics courses were conducted. The MOS courses were delivered once each to Army National Guard and Army Reserve soldiers who were seeking to be reclassified in these MOSs:

Army: Unit Administrative Specialist (71L, level 10--entry level) This 73-hour course was presented in a two week block. The 71L10 soldier is responsible for routine office administration and works at various organizational levels throughout the Army. Twenty-six hours of on-site typing instruction were provided.

Army: Unit Supply Specialist (76Y, level 10). This 96-hour phase of the 76Y10 course was presented in a two-week block. The 76Y10 soldier performs unit and organizational supply tasks, including receipt, storage, issue and accountability of supplies and equipment.

Army: Basic Military Police (95B, level 10). This 66-hour phase of the 95B10 course was presented as a two-week block. The entry level MP performs the tasks of apprehension and search, patrol and traffic operations, investigations, physical security, and self-defense.

The two special topics courses addressed joint services needs and were made available to members of interested services and components:

Navy: Handling Hazardous Waste (HazWaste). This was offered three times as a one-day course. Course topics included a review of pertinent laws and regulations, a discussion of the physical and chemical properties of hazardous materials, the correct techniques for delivery and transfer of materials to hazardous waste collection sites, and pollution and spill prevention.

Navy: Total Quality Leadership (TQL). This was offered two times as a one-day workshop. It was an introduction to the Navy's adaptation of W. Edwards Deming's approach to continuous quality improvement.

The courses were delivered to three Florida community college remote sites: St. Petersburg Junior College (SPJC), Valencia Community College (VCC) in Orlando, and at FCCJ. HazWaste and TQL were also offered at two out-of-state sites during the final administrations of these courses: Ft Taylor Hardin in Montgomery, Alabama and Camp Fogarty in East Greenwich, Rhode Island.

Course Reconfiguration

The five courses had to be converted from the standard mode of platform delivery to VTT delivery. The five-component Systems Approach to Training (SAT) model was adapted for use in reconfiguring the courseware. In the adapted model, the five functions of the SAT were included (i.e., Analysis, Design, Development, Implementation, and Evaluation). Due to the complexity of the reconfiguration effort, two functions were added (Revise Instruction and Management).

The five courses that were reconfigured in the FTP were assigned by the government. Therefore, the traditional tasks performed during the analysis phase of the SAT model were not conducted during this project. However, these courses were analyzed for their suitability for VTT according to the criteria provided by NAWCTSD.

During the design phase, the Programs of Instruction (POIs) and syllabi were analyzed to determine the adequacy of the course materials from an instructional design perspective. In the Development Phase, the instruction was developed and produced. All course materials were developed during this phase of reconfiguration. Preparation for, and the delivery of, instruction were the primary goals of the implementation phase of the reconfiguration process. The Revise Instruction Phase was added to the adapted model because several revision and validation cycles had to be performed during the reconfiguration process. The Management Phase was also added to the adapted SAT model because of the complexity of the project. Three primary groups of people had to coordinate multiple tasks for the success of the project: (a) the design, development, production, implementation, and evaluation teams, (b) the military organizations and groups involved in the project, and (c) the three community colleges.

A considerable amount of data was collected during delivery of the courses (Evaluation Phase). One of the roles of project personnel was to collect data from students, and data were collected from all project personnel.

Course Delivery

Instruction was presented *live* over TNET (Compression Laboratories' Rembrandt II 06™; compression rate 256Kbps). At the origination site, the primary person responsible for content presentation was the VTT Instructor. The content of the courses, however, required that a military instructor/SME, the Military Instructional Assistant (MIA), deliver some of the content. During delivery, up to three people were needed to implement the instruction.

At each remote site, a community college site coordinator, known as the Instructional Coordinator (IC), was needed as the instructor of record for each course. The IC also performed some of the off-line instructional roles. For the MOS courses, a Military Site Coordinator (MSC) was also required. The IC and MSC were the VTT Instructors' representatives at the remote sites. It was their responsibility to manage the instructional activities at each remote site.

Evaluation Methodology

Students

Students were selected by their respective military commands for participation in this project. A total of 275 students were trained during the project. All four services (including the reserve components of the Army and the Air

Force), and the U.S. Coast Guard were involved: Florida Army National Guard, Florida Air National Guard, U.S. Army Reserve, U.S. Navy (military and civilian personnel), U.S. Marine Corps, U.S. Coast Guard, Rhode Island Air National Guard, and Alabama Army National Guard.

The average age of all the students was 33.37 years. All of the students were high school graduates or the equivalent and 15% had a four-year college degree or more. A military grade of E5 was selected as an approximate estimate of the numbers of students who were managers versus those who were first line supervisors and enlisted personnel. Approximately 63 percent of the students were E5s or below. In addition, approximately 30 percent of the students had a military duty position related to the course in which they were enrolled and 4.9% had a civilian occupation related to the course content.

Students were asked how interested they were in the course content prior to taking the course. Approximately 73 percent rated themselves as very interested (5 on a 5-point scale). Approximately 19 percent reported that they had taken a course taught by television

Evaluation Instruments

There were 40 different data gathering instruments developed by FTP personnel in conjunction with Systems for Training and Applied Research, Inc., Lexington, Kentucky. These included achievement/proficiency test, student course perceptions, student ratings of course components, and interview forms. The achievement/proficiency tests were criterion based. Those for the MOS courses were Performance tests (PTs) developed by the military. Other performance tests were developed by project personnel. In addition, six standard Army forms were also used to collect test data.

Typical items from the instruments developed by the FTP include the following:

Dichotomous data, usually "yes/no" responses or "like/did not like," for example,

If you had the opportunity to take additional military teletraining instruction in the future, would you want to? ______*yes* ______*no*

Ratings on a 3- or 5-point Likert scale, where the highest number is always the most positive response, for example,

Please rate the aspects of this course on a scale from 1 to 5 or mark NA if the item is not applicable to this course:

5 = Excellent
4 = Very Good
3 = Good
2 = Below Average
1 = Poor
NA = Not Applicable

1.	*The VTT instructor's poise, personality and enthusiasm.*	*1*	*2*	*3*	*4*	*5*	*NA*
2.	*The VTT instructor's delivery of information over the network.*	*1*	*2*	*3*	*4*	*5*	*NA*

Ranking a series of responses (coded so the highest number was always the most positive), for example,

If you could pick from the following military training options in the future, which would you prefer as a method to receive training?

_____ *Traditional classroom instruction at a military school*
_____ *Video teletraining at a community college site*
_____ *Correspondence study*
_____ *Training provided locally by an assigned military instructor*
_____ *Video teletraining received at your armory/reserve center*

Open-ended questions, for example,

If you could have changed something in the course, what would it be?

Procedures

The five courses produced by the FTP were delivered between October, 1992 and February, 1993. Data were gathered from the course participants as well as from the staff responsible for facilitating the instruction.

All student and instructional personnel interviews were conducted by the project evaluators according to a predetermined schedule. Individual student interviews were conducted by the project evaluators immediately after the students completed the questionnaire(s).

The evaluation and cost data were coded as necessary and entered into a database. The Windows version of the Statistical Package for Social Sciences (SPSS for Windows 5.0) was used to analyze the evaluation data.

Results

The following list is a brief overview of the major findings related to the FTP. A more complete analysis of the data can be obtained in Bramble and Martin (1995), Martin and Bramble (in press); and Martin, B. L, et al. (1994):

Technology:

TNET was 99% reliable; students and instructional personnel rated the quality of the system high.

Students and ICs indicated that they preferred a VTT approach to traditional training at a military facility.

The courses selected for VTT presentation were generally suitable for the technology although some modifications were made (e.g., off-line activities) to accommodate the technology and the course content.

Even though training was provided, the instructional personnel felt that more training and practice was needed on TNET.

Instruction

The most important objective was the quality of instruction. All students passed the stated learning objectives, and over 90% of all students in the MOS courses passed the performance tests on the first attempt (See Table 1).

No comparisons could be made between the performance records of students in the VTT courses and those in other training options.

Students rated the learning methods and activities, including the interactivity provided in the VTT courses, to be effective (See Table 2). The opportunities for interaction were rated the highest, although interaction with students over the network was the most difficult interaction to achieve. Based on data collected during the interviews, students said these learning methods stimulated their interest and they were generally motivated by the VTT instruction.

No student demographic variables predicted success or lack of it for military students and hence one can expect that VTT is an acceptable approach for the general military population.

Students rated all the instructional personnel, VTT instructors, MIAs, ICs, and MSCs, as effective. A question was whether or not civilians can provide quality instruction to military students due to their lack of military training. Some students felt that a military instructor should have presented the instruction, however, all students passed the learning objectives for all five courses.

Community Colleges

FCCJ had the technical and instructional capabilities to implement VTT instruction. The technical staff, TV studio, and production facilities (one of the best among community colleges in Florida) were excellent.

Community college faculty are professional educators. While the faculty at FCCJ lacked instructional design and military training expertise, they were able to design and present high quality instruction given specific training.

Staff training was presented to all instructional and technical personnel. This training was judged to be of high quality by the staff and they indicated that it enabled them to perform their roles and responsibilities.

The course developers/VTT instructors had the most extensive training of all the instructional personnel. This included instruction in VTT presentation, instructional design, and military training.

The community colleges were able to grant academic and continuing education credit for all courses. Although not all students were interested in receiving credit, those that were, indicated that college credit was a definite advantage to receiving military training at a community college.

The three community colleges were organized to work together through subcontracts; this proved to be a very effective mechanism.

There was a complex web of community college, university, government, and military organizations that had to work together to implement this project. Formal contracts, MOUs, IPRs, and a number of informal agreements enabled the groups to work together effectively.

Costs:

With the exception of the HazWaste course, the VTT courses in the FTP were more expensive when compared to resident training. The HazWaste course was cost effective because there were a large number of students (N=116) in the course and because of travel and per diem savings.

The costs associated with providing college credit (in-state and out-of-state) and the lease of the four TNET systems greatly increased the costs of the VTT courses.

The VTT courses become more cost effective if: (a) the same course is presented more than once (because design and development costs are paid only once), and (b) different courses are presented in the same month, (because each course would be charged only for the days the course is implemented rather than paying the TNET costs for the entire month).

Lessons Learned

The pilot test and project provided several lessons about designing and implementing VTT instruction. While some lessons are more relevant to military instruction, others are important for planning any VTT project:

The choice of technologies, in this case TNET, influenced the design of instruction because of the video transmission rate. The FTP courses are not directly adaptable to other VTT systems. They would have to be modified to be used effectively. Adapting the courseware will typically be needed when changing delivery methodologies.

Origination and remote site technicians are invaluable resources. Origination site technicians should be knowledgeable in various communication technologies.

Adequate staff training is necessary for successful VTT instruction. Instructors and course developers need instruction in basic ISD, how to conduct instruction using the selected distance delivery system, and how to operate the equipment.

VTT must be considered in the context of other training options. Courses should be selected for VTT delivery that are short (one to two weeks in length), are primarily cognitive, and have high demand or throughput.

While the TNET equipment is not difficult to use, some personnel are intimidated by any new technology. Care must be taken to provide sufficient practice and technical support to such personnel when the technology is in use.

Military programs of instruction (POI) and syllabi can be successfully reconfigured for VTT instruction. The quality of the POIs and syllabi received from the military directly effects the time and the costs for reconfiguring military courses for VTT.

Careful attention must be paid to designing activities that allow students to interact with each other on the network.

It took longer to present RC^3 courses by VTT than to present platform instruction because of planned interaction and the administration of on-site PEs. Typically, the overall course length will increase when using VTT in order to present the same content.

Students who were more highly educated or held a higher military grade or rank were more critical than others of the interactive study guide (word picture concept) that was used in this project. Other ways of involving these students in the instructional process needs to be explored.

The different cultures of the military and the community college, in addition to the roles and responsibilities assigned to each group, require coordination by individuals who can link the two communities.

Course design, development, and delivery required a team approach because the community college faculty who taught the courses did not have sufficient military background.

The larger the population that can be served using VTT, the greater the cost savings. On-going VTT programs will be more cost effective than one-shot courses.

Conclusions

Video teletraining, like other forms of distance education, can be a viable option for increasing training and education possibilities for military reservists as well as for non-military populations. The costs of such programs depend on a number of factors including the technology used, how extensive the course design and/or reconfiguration effort is, the number of support personnel required, how long the training program is, and how much staff training is required. The benefits that may accrue from quality distance education programs include improved instruction, broader access to training, delivering instruction in a variety of settings, and less travel by course participants.

It is important, however, to keep in mind that good distance education programs are highly dependent on good planning (ISD), good instruction (presentation), and good organization and management (Cornell, 1995; Martin & Bramble, in press). Failure to attend to these important aspects of a distance program will likely result in poor instruction and learning just as platform instruction that is not well planned and well managed will also result in poor instruction and learning. That is, good instruction is good instruction regardless of whether it is presented in a classroom or at a distance.

Note: The Florida Teletraining Project was conducted under contract number N61339-85 from the Defense Training and Performance Data Center (TPDC) to the Institute for Simulation and training at the University of Central Florida. With the closing of TPDC in 1992, contract management was transferred to the Defense Institute for Training Resources Analysis (DOITRA). Dr. Steven Skiles and Mr. Bill West served as DoD Project Managers.

Table 1

Pretest and Posttest Performance Data

Course	Performance Test Measure	Pretest (SD) (N)	Posttest (SD) (N)	t-value (df)
ADMIN	Timed Typing	20.48(9.58) (33)	32.42(9.58) (33)	11.41* (32)
	Type a Memorandum (# errors)	7.42(4.81) (33)	1.85(1.54) (33)	6.97* (32)
SUPPL	50-item Achievement Test	59.95(16.63) (40)	76.00(11.25) (40)	8.57* (39)
MP	90-item PT[a]	71.81(10.22) (26)	92.58(10.22) (26)	13.56* (25)
HAZ	20-item PT	47.68(13.53) (111)	78.23(10.95) (111)	21.54* (110)
TQL	20-item PT	No pretest given	82.90(11.01) (48)[b]	NA

*$p<.001$, one-tailed.

[a] PT = Performance Test

[b] Note: There are 11 missing scores from the Rhode Island site.

Table 2
Selected Student Ratings of Instructional Methods, Interactivity, and Course Characteristics
(5 Point Scale, 5 = Highest)
(SD)
(N)

ITEM	ADMIN	SUPPLY	MP	HAZ	TQL
Word graphics	3.65 (1.14) (31)	3.82 (1.23) (38)	3.44 (1.04) (25)	4.33 (0.77) (110)	4.43 (0.65) (47)
Value of Practical exercises	4.18 (0.98) (33)	3.44 (1.19) (32)	4.04 (0.89) (25)	4.26 (0.82) (111)	4.15 (0.81) (47)
Instructional games	2.61 (1.45) (28)	3.44 (1.19) (32)	3.46 (1.25) (24)	NA	NA
Remediation helpful	4.13 (0.88) (31)	3.68 (1.02) (40)	4.05 (0.80) (21)	NA	NA
Opportunities to ask questions	4.09 (0.89) (32)	4.03 (1.19) (40)	4.31 (0.84) (26)	4.18 (0.89) (111)	4.21 (0.77) (48)
Interaction w/ students on-site	4.62 (0.61) (32)	4.47 (0.82) (40)	4.58 (0.50) (26)	4.33 (0.74) (111)	4.11 (0.76) (47)
Interaction w/st. on-network	3.38 (1.48) (32)	3.50 (1.41) (40)	3.08 (1.06) (26)	N/A	N/A
Interaction w/VTT instructor	4.23 (0.88) (31)	4.15 (1.08) (40)	3.60 (1.15) (25)	4.33 (0.74) (111)	4.23 (0.73) (47)
General course organization	3.00 (1.22) (32)	2.95 (1.18) (40)	3.38 (1.06) (26)	3.84 (0.93) (111)	4.06 (0.95) (48)
Quality of lesson presentations	3.44 (1.01) (32)	3.28 (1.13) (40)	3.19 (1.17) (26)	3.95 (0.85) (110)	4.00 (0.83) (48)

Table 2 (continued)

Time to cover topics	2.69 (1.12) (32)	3.68 (1.02) (40)	3.42 (1.33) (26)	3.24 (1.22) (111)	3.13 (1.21) (48)
Overall course quality	3.59 (0.98) (32)	3.55 (1.18) (40)	3.19 (1.10) (26)	4.04 (0.92) (111)	4.10 (0.81) (48)
Pacing of course (3=about right)	3.48 (1.34) (31)	2.68 (0.91) (34)	2.04 (1.06) (25)	2.94 (0.86) (110)	3.11 (0.87) (47)

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Title:

The Relationship Between the Training Function and ISO-9000 Registration

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Objectives

This paper will focus on the training aspects of ISO 9000 Quality registration. The objective of this paper is to report on an application and case study in a global organization that successfully achieved ISO 9000 Quality registration. An essential element in the certification process is an appropriate training system. The training system is important in two ways. First, the communication of the ISO requirements to all levels of the organization is essential for certification. Second, the training function is important for performance improvement to maintain quality standards and continually improve the quality processes. The following content areas will be covered:

- ISO 9000 Overview
- ISO 9000 Requirements
- Training Requirements
- Case Study
- Role of Information Technology
- Reducing Costs

ISO 9000 Overview

Most organizations produce a product or service that is intended to satisfy a user's needs or requirements. Such requirements are often incorporated in specifications. Quality is traditionally measured in terms of conformance to specifications. Conformance to specifications does not guarantee that a customer's requirements are met. Quality system standards and guidelines were developed that complement relevant product or service requirements given in the technical specifications. The series of international standards, ISO 9000 to ISO 9004, embodies a rationalization of the many and various national approaches in this sphere (ISO Quality Standards Collection, 1991). The ISO 9000 standards were adopted in 1987 by the International Organization for Standardization (ISO). The ISO 9000 certification demonstrates the capability of a supplier to control the processes that determine the acceptability of the product or service being supplied (Rabbitt and Bergh, 1994).

ISO 9000's basic requirement is that there must be adequate management of whatever activities are involved in creating products (Oskarsson & Glass, 1996). The ISO standard defines and documents management's role in putting quality into a product. Product quality had traditionally been placed in the technology camp with procedures such as measuring product defects. ISO 9000 is in the quality management camp instead of the technology camp. The standard is written at a policy level with little technical advise on how to accomplish what it requires. The methods seem superficial and bureaucratic. In addition, the standard was defined by quality people. The originators knew a lot about quality, but little about the discipline to which it is applied. This issue is particularly problematic for functions like R&D and processes like software development, where the products have no weight, are created by knowledge workers and require no raw materials to produce. The standard also originated in the manufacturing world in which performance gaps in quality are measured concretely.

The basic benefit of the ISO 9000 standard is that it is a system used to measure and evaluate an organization's quality management system. Assuring customer satisfaction and gaining competitive advantage are the two main reasons for incorporating the ISO standard in a company. The ISO 9000 system uses formal audits and a registration procedure to assure customers around the world that a supplier is applying a high level quality system in producing and delivering its goods or services. These standards are now being met in companies of over 70 countries worldwide.

ISO 9000 Requirements

ISO 9000 is a family of standards and guidelines. There are different standards based on the type of business that is registered. The document ISO 9000-1 is a general guideline that gives background information about the family of standards. ISO 9001, ISO 9002, and ISO 9003 are the standards in the family, containing requirements on a supplier. ISO 9002 and ISO 9003 are subsets of ISO 9001. ISO 9002 is used for situations in which there is no design. ISO 90003 is used in situations in which there is neither design nor production (e.g. retail). Typically for both hardware and software product development, ISO 9001 is the standard to use. ISO 9004 is a comprehensive guideline to the use of the ISO 9000 standards. ISO 9004-3 is a guideline on how to use ISO 9001 for development. ISO 9004-2 is a guideline for the application of ISO 9001 to the supply of services. It can be of interest in the context of information technology, since computer centers and other suppliers of data services can benefit from its use.

The ISO 9000 standard focuses on 20 aspects of a quality program that are subject to a rigorous audit during the certification process. Each section relates to a specific aspect of satisfying customers. These elements should be viewed in terms of how they relate to a customer's expectations. The following 20 elements are contained in section 4 of the ISO 9000 standard document.

1. *Management responsibility*
2. *Quality system*
3. *Contract review*
4. *Design control*
5. *Document and data control*
6. *Purchasing*
7. *Control of customer specified product*
8. *Product identification and tractability*
9. *Process control*
10. *Inspection and testing*
11. *Control of inspection, measuring and test equipment*
12. *Inspection and test status*
13. *Control of non conforming product*
14. *Corrective and preventive action*
15. *Handling, storage, packaging, preservation and delivery*
16. *Control of quality records*
17. *Internal quality audits*
18. *Training*
19. *Servicing*
20. *Statistical techniques*

The ISO 9000 elements must be viewed as a system. A system is a group of interacting items that form a unified relationship. A quality system is defined by the organization's management and is documented in the organization's quality system manual. The manual defines the organization's processes according to the 20 ISO elements. In general terms a quality system is defined as follows:

> *Quality System:* The organizational structure of responsibilities, procedures, processes, and resources for implementing quality management (ISO Quality Standards Collection, 1991).

ISO 9000 does not specify quality assurance standards. Those standards are defined by the organization. ISO 9000 provides a model for quality assurance that can be adapted by the organization as it sees fit. The model can only survive as an operational system if various departments in an organization continuously interact to monitor/audit the system and its effectiveness. Audits are required every year by independent outside auditors. In essence, ISO 9000 is a quality system that attempts to certify to customers that an organization will do what it says it will do in terms of determining product requirements, product development, product manufacture and product service.

Training Requirements

The standards require that staff are trained for their tasks. They further specify that the supplier to have a procedure to:

- Identify training needs for each staff position.
- Provide such training.
- Keep records of the training of all staff members.

Oskarsson and Glass (1996) highlight examples of the kinds of training an auditor would expect to see planned in software development:

- New programming languages and tools.
- Audit training for internal quality auditors.
- Project management training.

The auditor does not judge an organization's means of training and education but that the training is documented and sufficient. The criterion for sufficient training is that a person is capable of performing his/her work to a high enough standard. The auditor may see this in quality review records and project success. The records of training are essential for compliance with the standard. Examples of typical training nonconformances are:

- No procedure for planning of training.
- No training records.
- An employee who has not received proper training for his or her task.

The training procedures should start by describing how you identify training needs. This is done through the use of job descriptions or profiles. Job descriptions should detail the minimum qualifications required for assuming a position or performing a work function. The job descriptions are required as a basis for establishing a training program. The job description should state what the skill or education requirements are for a particular job. Documentation also needs to exist for each individual indicating whether they meet the job requirements. It is not always possible for every new employee hired or promoted to be trained in every aspect of a job the moment they begin. In these situations, a formal plan should be developed indicating that training will be completed in a reasonable amount of time. Randall (1995) suggests developing a training needs matrix showing the departments in an organization on one axis and the ISO element on the other axis with checks in the matrix indicating that a particular department undergo more detailed training in a particular ISO element.

Documenting training programs is essential in the ISO standard. Undocumented training programs in which a large amount of information is passed verbally from one person to another do not meet the intent of the ISO requirement. This does not mean that all training must be the result of formal classroom training courses. Many companies have formalized "on-the-job" training and apprenticeship programs. These training programs must be documented and formalized to the extent that they go beyond mere tribal knowledge. Training and education techniques such as action learning need to be documented as well.

If an employee meets the requirements of a position because of their experience, it is not necessary that they participate in training that is not needed. Their experience should be documented in their training records indicating that they meet those specific requirements of the job.

Training records must document that stated qualifications have been met as "appropriate education, training and/or experience, as required." Documenting the above can be accomplished with:

- Certificates, degrees, diplomas, licenses, etc.
- Course descriptions, course outlines, together with instructor identification and qualifications to teach the assigned courses or skills.
- Letters, memos, etc., documenting experience.

Case Study

This case study involves a division of a telecommunications company that designs, manufactures and installs transmission equipment for customers in Canada, the United States, Europe and Asia. The implementation of the ISO quality system was performed in conjunction with other quality initiatives including statistical process control, continuous improvement, and process maturity/improvements. There was initial senior management support for pursuing the ISO Quality initiative, both at the corporate and divisional levels.

As with most change, the ISO 9001 implementation met with some resistance on the part of managers and employees. Resistance originated from a lack of understanding of the intent of the ISO quality management system, of information regarding the certification process, and the objectives sought. Some managers questioned the necessity of the ISO Standard, seeing it as an increase in paperwork. Others were apprehensive of the overtime work that such an implementation would require. These feelings were compounded by the variety of quality initiatives that had come and gone throughout the company.

The ISO system was implemented in phases throughout the division. First, the manufacturing location went through the ISO 9001 certification program and achieved certification with no nonconformances. The success of this initial certification was due to two factors; a small core team of less than 20 people who took responsibility of the elements, and a good project manager who was able to bring together many organizational departments for a common purpose. In addition, the manufacturing location had a strong plant manager who was very supportive of the program. Certification at this point was focused on the local level. The success of this initial effort was a good learning experience in both the process and in pulling together as a team, the functional units of the organization .

The rest of this case focuses primarily on the certification for the R&D part of the division. This aspect of the project involved many international elements because the R&D part of the division contained work groups located throughout the US, Canada, and the United Kingdom. In addition, the company had developed several improved methods of information and communications technology that were essential in implementing certification on a global scale.

The first few months of the project were a sensitization period that was necessary to convince managers, especially senior managers, of the advantages of the ISO 9001 quality system. This period was characterized by the *personal commitment* of the division's Vice President, Assistant Vice Presidents / Lab Directors at each lab. Once this commitment was achieved, a *core team* was formed. At each R&D location, team members were assigned responsibility for one or more of the 20 applicable ISO elements. In addition there was an *executive team* that spanned the corporate and divisional locations. Once the project was underway weekly video meetings as well as conference calls were established. The division also utilized a fairly extensive internal *computer network* file server system and internal e-mail system. The computer elements were essential in *sharing information* among the teams as well as providing an electronic medium to store and retrieve quality and process information needed for all locations. Having up to date current and controlled documents available to everyone is an essential feature and audit point in the quality standard. Electronic media is very important in adhering to the standard on a global basis with several geographic locations.

The development of the quality system with the associated quality manual is the first and most important step in the certification process. In this manual, the overall quality system is defined and responsibility is designated. The organization's system with respect to each of the applicable elements are defined and described. Associated documented processes are also referenced in this manual. ISO certification must be achieved through an independent auditor. There are many types of organizations that provide this type of service. Once the certification agency was selected, they visited the locations and educated the executive and core teams on the certification process. The certifier then reviews your quality manual before you go though the ISO audit. The quality manual is really the basis for your certification audit.

The development of the quality manual proved to be an interesting and time consuming part of the process. There were two issues to balance in the development of this manual. The issues were a central corporate thrust on the quality direction as well as local processes at each site. There was quite a bit of dialogue as to what processes were common and unique to each site. The result was a divisional manual as well as each site developing a manual for its unique processes. The ISO certification process is handled by each site with each location being certified. One important step in ensuring success is to have a person that is your site internal auditor so that the processes can be audited before the final audit.

A number of processes were developed and adapted as a result of the ISO process. One item that was significant to the R&D environment was requirements analysis. Documenting and communicating what the actual requirements are for a software and hardware development project was an important addition. As a result, the development process included what was called Product Development Quality Plans (PDQP's) for each major design effort. Processes were set up to review and sign off these documents with all appropriate groups. The PDQP was a link to customer requirements. The documents forced more communication with customers.

Training was essential to the certification process. There were both formal and informal elements. The independent certification audit is a test of everyone's understanding of the process as well as whether the defined processes are in place. During certification, an auditor randomly selects individuals in the organization and interviews them. They are questioned on the processes they are following, how they get access to the quality records that contain the organization's quality position, as well as the elements and processes that apply to their job. Training first addressed the ISO process itself. There was training at each site on its quality system and the process used by employees to obtain quality records. Employees also had to be trained in determining if they were accessing the most current version of documents. Training all employees to access documents electronically proved beneficial.

Training in the ISO system is also necessary to ensure that all employees are qualified to do their jobs. Prior to the ISO implementation, training completion records were kept for completed courses. There was, however, no formal process of needs assessment tied to job qualifications. The ISO system forced the division to examine jobs/position profiles and determine the requirements for each job. As mentioned above, the ISO standard does not say that every individual has to meet the requirements initially, but a training or development plan has to be in place for a person to meet those qualifications. A global curriculum committee was established to determine the needed skills in each function in each lab. The skills included both technical and personal development skills. Training profiles were developed for individuals. The training departments at each location worked with line managers to ensure that each employee completed a training profile with their manager. The profiles were signed on a hard copy by the manager and employee. The profiles were summarized by the training function to develop the overall training plan for each lab. The training plans together with other needs assessment tools helped in determining training budgets and appropriate types of instruction. The initial job descriptions, usually kept by Human Resources, are important for audit purposes. The auditor will examine the job descriptions first and then examine random employee profiles to determine if the qualifications and development plans match.

After approximately a year of effort, all R&D lab sites achieved certification on the first audit. The sites were also recertified one year later. After the first year, the division went though a massive reorganization linking marketing, product line management, and systems engineering into a common business unit to improve customer effectiveness. The certification process now expanded to include the entire business unit. The executives in this business unit viewed the ISO process as one way to establish the organizational links and teaming to achieve this business integration. The ISO process proved an effective way to do this. A successful audit was completed for the entire business unit less than six months ago. There were several initiatives established to link the R&D effort directly to customers. In a recent Core Quality Team meeting, the ISO process was recognized for its contribution to the reorganization.

Comments from the independent audit group were very positive and highlighted important elements of a quality system:

> You have a unique, integrated quality system, which is among the best I have ever seen. It is well structured, well thought-out and well applied to meet the ISO 9001 requirements.
>
> This is the first time I have seen a Design group take a lead in customer interaction by talking to customers at the early stages of the design.
>
> Your Quality System Reviews (QSRs) are truly impressive in the fact that it covers the entire scope of the Business Indicators.
>
> You have effectively applied the Quality System to clarify Roles and Responsibilities between ... functional groups.

The important themes were linking of functional groups and the link to the customer. Training can have a role in this effort by designing learning experiences that link the business group to the customer. In this particular division, seminars and field trips are made to customer sites as often as possible to help firm up the link to the customer.

Role of Information Technology

The ISO standard really is a method of information exchange. It is a method for documenting processes to empower everyone in an organization to meet customer expectations. The role of information technology proved essential to this communication. Documents were continually developed, reviewed, and electronically exchanged, in an information network. The electronic file storage provided the required vintage control so that everyone worked from the same version. One factor that must be considered in utilizing this type of information network is the selection of the software and hardware platforms. In this case, framemaker was used for all ISO documents because it could be sent through a variety of computer hardware platforms such as Macintosh, DOS, and UNIX without many conversions and reformatting. Another lesson learned through this process was designing for useability by all employees on the network servers as well as providing training on accessing information.

Reducing Costs

Implementing the ISO process during major budget cuts in an organization is a challenge, particularly when it is done globally. As mentioned previously, utilizing video meetings and conference calls will reduce the needs for travel. An important method that will help to keep costs to a minimum is to develop and keep processes as simple as possible while still meeting the intent of the standard. Realize that processes will change and will be revised. In terms of training, an extensive curriculum based system is costly. Training is becoming more performance based. Performance analysis should be done with employees. There may also be a need for basic competencies training in addition to performance issues.

Hale and Westgaard (1995) outline some simple steps in process development that impact the budget:

- Agree what the steps are.
- Reach consensus on what steps are necessary.
- Specify what resources (e.g., time, equipment, information) each step of the process and the process as a whole require.
- Evaluate which resources add value, are used well, are redundant, or reduce quality.
- Determine cycle time.
- Agree on what information is required and what is nice to know.
- Come to consensus about how information is used, where it comes from, and what information is missing, late, or complete.

The cost for ISO certification is mainly internal except for the expense of the independent auditor. The typical cost for the independent audit group, for the initial certification, is approximately 25K and approximately 10K per year after that. The above case was for a location of approximately 300 people. The external auditor goes through all the quality records, thus how well these records are organized will impact cost. The internal cost consisted of approximately a dozen people spending 10-20 percent of their time on the ISO process. Training and understanding in the ISO standards will minimize this expense.

Conclusion

The benefits of the ISO certification become more apparent after certification. Employees begin to realize later that the ISO process will actually simplify their work (Todorov, 1996). Achieving the standard in organizations is an indication that information flow and training are greatly improved. Ultimately, there is a decrease in functional defects in a company, a reduction of nonconformity's, and greater discipline in process execution.

There have been instances where productivity improvements have been documented due to the ISO standard. The management model proposed by the ISO standard may in some cases permit a decrease in the manager/employee ratio as a result of autonomous work teams and greater responsibility given to employees. By empowering people, senior management is relieved of the management of daily activities and can concentrate on more strategic aspects of the business. The ISO standard provides this improved empowerment model by ensuring information on the companies quality system, customer links, and processes are documented and are available to everyone. Employees have at their disposal concrete tools (training, work instructions, forms, etc.) to perform quality work (Todorov, 1996). Instructional and information technology can facilitate the implementation of the ISO standard on a global basis.

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Title:

Dimensions of a Knowledge Support System: Multimedia Cases and High Bandwidth Telecommunications for Teacher Professional Development

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The Common Thread Case Project is a multi-year project that uses multimedia compact disc technology and high-bandwidth telecommunications to provide a unique, case-based professional development network for teachers in the midst of systemic reform in the state of Kentucky.

The project, now in its second year, is a partnership between the University of Kentucky, the University of Louisville, and Kentucky Educational Television. Year one of the project centered on the development of a series of five secondary and five elementary cases, available in both hard copy and CD-ROM. Each case in the series, called The Common Thread Cases, is a true story and captures the dilemmas and accomplishments of teachers involved in reform. The criteria for the Common Thread Cases (CTC) have been fully described elsewhere (Bliss & Mazur, 1995a). However, the case criteria are salient to the present discussion and are reiterated in Appendix A.The cases are designed for in-depth discussions that critically analyze pedagogy and promote reflection. Year two of the project focuses on training and dissemination of the case materials. The intent of the training is to provide teachers with case facilitation skills and technology to develop and support a professional community of teachers. In addition to case facilitation training, the project also is working with participants to explore telecommunications for ongoing professional development and collaboration. Currently, we are examining two questions potentially crucial to the project's long-term success.

(1) To what extent can the cases, along with accompanying study tools and resources and available telecommunications technology, become the nexus of a larger system of knowledge support that is essential for teacher professionalism?

(2) What are the dimensions of such a knowledge support system?

Background and Need for Knowledge Support

Kentucky teachers face unique challenges. Now in its fifth year of implementation, the Kentucky Education Reform Act of 1990 (KERA) requires comprehensive reform in governance, finance, and curriculum. The reform includes an extensive technology initiative, the Kentucky Educational Technology System. The purpose of the statewide network is to improve instruction and support teacher professional development (Kentucky Master Plan for Technology, 1992) through the use of telecommunications and on-line resources. Schools are now required to provide high-end desktop computing in classrooms. An integrated wide-area network will connect all the states' school districts, colleges and universities, and governmental agencies. Such an extensive network in a largely rural state is intended, in part, to support the professional needs of teachers -- teachers who are expected to engage in new types of teaching (e.g., portfolio assessment) and problem-solving activities. For novice teachers, performance is now assessed through portfolios in which they demonstrate what they know and are able to do consistent with state adopted performance standards.

Several recent studies of the KERA implementation have stressed the need for more strategic professional development approaches (Robertson Associates, 1995). Teachers want more examples of new practices and ongoing support for incorporating new approaches (Mathews, 1995; Daniels & Stallion,1995). Moreover, to be more effective in meeting the needs of teachers, technology should be integrated into flexible professional development (Mazur, 1995).

Cases and Teacher Professional Development

Cases have been used for teacher professional development for some time and for a variety of purposes (Wasserman, 1993; Kagan, 1993; Kleinfeld, 1989). Among the most prominent uses of the case approach are (1) to support collaborative work between experts and novices and to compare differences in novice and expert approaches (Borko et al., 1992; Borko & Livingston, 1989), (2) to frame situational learning (Koschman et al, 1990) and (3) to examine expert decision making in complex, ill-structured domains (Spiro et al. 1988). In addition, cases contextualize problem solving? (Cognition and Technology Group, 1992, 1991; Risko, 1992b; Risko, Vount & Towell, 1991). However, electronic cases for educators (Fishman & Duffy, 1992, 1993; Desberg, Colbert & Trimble, 1995) have been developed only recently.

Each Common Thread Case CD-ROM contains the entire discursive text of the hard copy case transformed into a multimedia "animated narrative. That is, the text is augmented with accompanying non-discursive descriptive material consisting of high quality graphics, video clips and audio narration. These enhancements are intended to provide teachers with multiple ways of knowing the subject (Eisner, 1993). Strategic case content locators and graphical overviews provide several ways to navigate through the case content. A variety of tools and resources designed to supplement study and discussion of the case are also provided: Case discussion questions, exhibits such as lesson plans and examples of students' work, case commentaries by teachers, administrators, and scholars, a case bibliography, and relevant articles are included. Each CD contains telecommunications shareware that facilitates the use of on-line networks to discuss questions or issues related to the case. A World Wide Web homepage for the project is also available (http://www.uky.edu/~borchyi/KERA.html).

Knowledge Support and Performance Outcomes for Teacher Professionalism

The Common Thread Cases are consistent with a proposed approach to upgrade teachers' skills is through integrating powerful new technologies with teacher professional development (Barron and Goldman, 1994)). However, many of the problems related to technology and productivity identified by business and industry have resurfaced in professional development for teachers (Lieberman & McLaughlin, 1992). For example, educators, like their counterparts involved in training for business and industry, have seen the poor results of one-shot, one-size-fits-all training that does not provide opportunities for ongoing practice and feedback on performance (Savage, 1994). To combat this problem new systems, termed on-line performance support systems, have been designed to link innovative applications to new learning, working, and collaboration paradigms (Schoenmaker, 1993). These systems have been described as *continuous learning environments* (Forman & Kaplan, 1994). That is, the system provides an array of integrated information resources such as references, guidance, or tools on the desktop that are under the users' control. Delivered via computer, this new generation of electronic performance support systems (Stevens and Stevens, 1995), provides immediately needed, task- and situation- specific information that is accessible from electronic? networks and/or multimedia databases. Using tailored navigational and indexing utilities, these systems can store vast amounts of information and embed training (Mullins, 1989) that can meet the needs of many users who may need the information for different reasons. The untapped strength of these new interactive and networked technologies lies in their potential to deal with complexity and sort out multiple factors involved in a problem (Savage, 1994).

What is the potential of these continuous learning environments for professional development in education? Despite some congruence with approaches generally termed constructivist (Duffy & Jonassen, 1993, Wilson, 1995), there remains significant conceptual differences between programs designed to support educational endeavors and the continuous learning environments used to support productivity in business and industry. One is the nature of the cognitive tasks involved in productive work. Teaching requires professional judgments regarding actual practice or technique that may vary widely in specific circumstances. Teachers' judgments requires what has been termed narrative, rather than paradigmatic, knowing (Bruner, 1991). There is no one set of prescribed rules or procedures that will work in any given set of circumstances.

Another aspect of the educational situation that is significantly different from business environments is that both novices and veterans are assigned similar tasks regardless of experience. That is, a first year teacher and a twenty-year veteran may both be teaching a class of mixed ability second graders in an urban school. While each has much to learn from the other, the time and opportunity are usually lacking to capitalize on the possibilities for mentoring or peer assistance (Little, 1991; Raney and Robbins, 1989). In addition, the traditional isolation of teachers has inhibited the sharing of pedagogical insights gained from experience.

The strategic role of dialogic conversation in enabling participants to create commonly shared meaning and to "transform their mindsets and think about change and education" has been recently conceptualized by Jenlink and Carr (1996 p. 34). Furthermore, Brown & Campione (1990) have described how essential a community of learners is to supporting critical thinking, reflection, and change. Specifically, networks of engaged participants can become the much-needed contexts for transforming practice.

Currently, there are a plethora of on-line services for teacher networking such as on-line discussion groups, bulletin boards, and extensive databases for information retrieval. But many users complain that electronic information is overwhelming, unfocused, or difficult to access (Harasim, 1990) and this perception has seriously limited the use of on-line resources for professional development. In their efforts to change practice, teachers need to engage in intensive, more structured professional communities and intellectual teamwork (Gallegher & Kraut 1991) than is now available. The Common Thread Case project seeks to begin addressing this issue through the integration of multimedia cases and telecommunications in an open, somewhat unstructured knowledge support system.

Dimensions of An Open Knowledge Support System

The knowledge support environment has to be robust enough to encourage thought and promote insight, open enough to allow users to raise topics that are personally relevant, and yet sufficiently focused to emphasize state-adopted teacher performance standards. The design of the knowledge support system must include three dimensions. These are:

(1) An Instrumental Dimension. The core content (the cases)and information contained in the resources must be rich enough to accommodate novice and experienced educators and appeal to a wide variety of experiences. Simultaneously, the performance standards, consistent with national standards, must play a prominent role. The design and presentation of information provides opportunities for studying complex pedagogy and offers multiple ways to access that information. Furthermore, the system's design should incorporate aesthetic aspects (Saito et al. 1995) that capitalize on the expressive potential of multimedia technology to motivate and engage the educational imagination described by Eisner (1986). The system also needs to be flexible and accessible to accommodate teachers' scheduling demands.

(2) A Relational Dimension. To enable the teacher to thoroughly analyze various aspects of a case as it relates to teaching standards as well as to theory and practice, the knowledge support system makes available integrative tools and resources. Examining, gathering, and linking information may involve questioning or clarifying the case situation, identifying key points, or seeking further information about case topics. Tools to help teachers elaborate on issues raised and double checking information--all of which are instantly available within the case program, comprise a relational dimension to knowledge support system that is structured not by the program's sequence but by the questions, interests, or concerns of the user.

(3) A Communication Dimension. The system incoporates tools that encourage and enable teachers to communicate their analysis of the case issues to others who have also used the case. Teachers can revise and create new ideas, capitalize on the experiences of others who may have tested ideas from the case and engage in the critical discourse so essential to the development of professional communities.

The chart below illustrates how prominent case features and telecommunications tools shown in Appendix B comprise various dimensions of the open knowledge support system.

Instrumental	Relational	Communication
Case content and accompanying visuals	Discussion Questions	Notebook
Exhibits	Explore Issues and Standards	E-mail tools
Case Commentary	Case Content Locator	Web site Desktop Video Conference
State & National Performance Standards	Where Am I? Navigator	
Bibliography/ Articles		

Future Directions

The program has been field tested with approximately fifty new and experienced Kentucky teachers. The most obvious issues emanating from the field tests concern the communications dimension of the knowledge support system. Not surprisingly, users were uncomfortable with initiating on-line video conferences with strangers. Also, the notion of on-going professional development carried out via electronic mail was, in fact, so foreign to most teachers that they had difficulty incorporating contacts with other teachers into their routines. Just as workers in business and industry had to adjust work habits to truly utilize the highly accessible resources in continuous learning environments, teachers apparently need encouragement and follow-up on the use of on-line forums and databases to support their work and professional development activities. Most importantly, the issue of sustainability was raised. What is necessary to maintain professional conversation and community once it has been initiated?

At this point in the implementation of the Common Thread Case project, the communications dimension needs careful investigation. As our research proceeds we will be examining which resources are most suited to supporting aspects of professional discourse. For example, will features of teleconferencing be more valuable for certain types of discussions, or only as the initial contacts for collaboration? What kinds of discussion will be best suited for e-mail? Will the World Wide Web forum or two-way video conferencing be the most effective model for study group discussion ? What additional resources, not yet available as part of the existing system, will teachers need and want? As refinements to the development of the communications dimension of the knowledge support system proceed, we hope to develop dynamic models for open, somewhat unstructured communities that empower teachers in their efforts to improve practice through conversation and community.

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Appendix A

The Common Thread Case Criteria

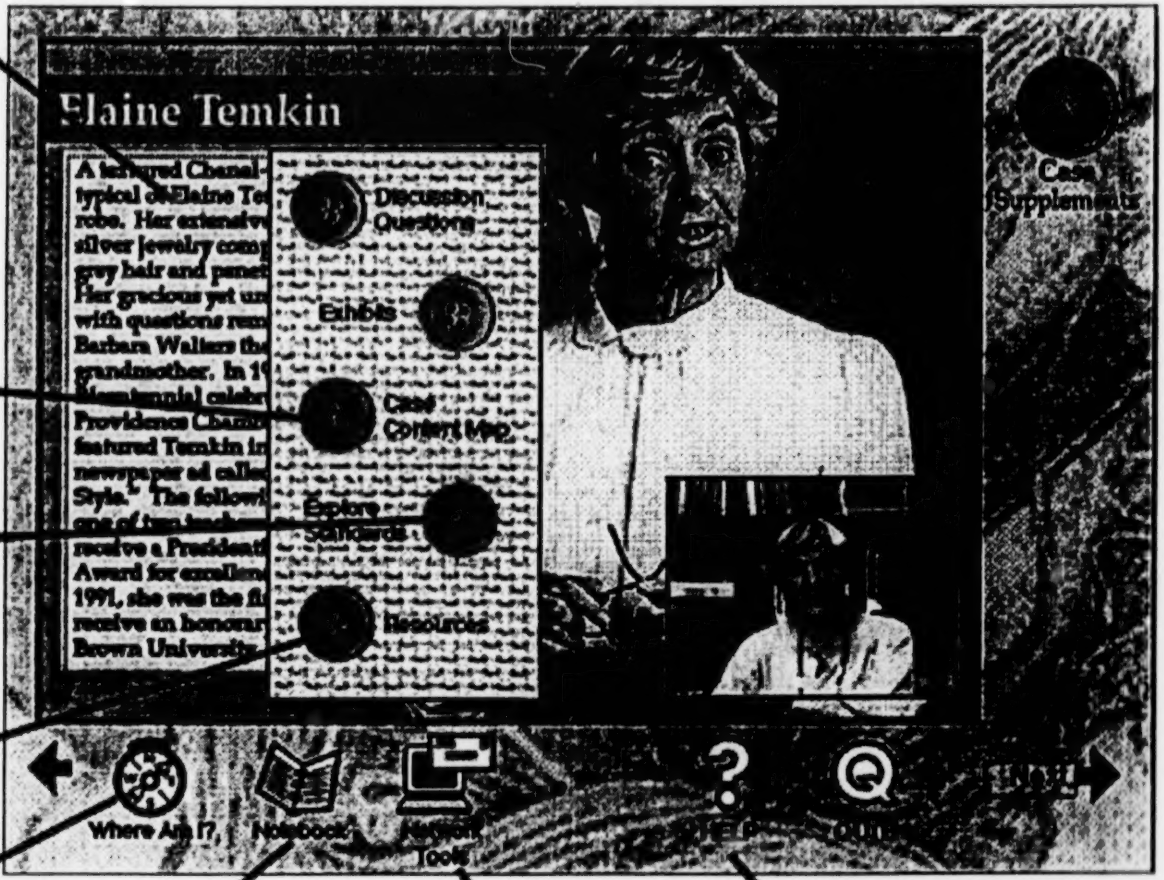
Each Common Thread Case contains four elements:

1. A well formulated narrative structure (Connelly & Clandinin, 1990)

2. A true, factually correct, compelling acocunt. The authenticity of the case is essential and strategic, as suggested by Phillips (1994), who notes that one is more likely to accept what is true and more likely to be successful when what one acts upon is correct.

3. Tangible episodes of good teaching. Teaching episodes must include the particulars that become tangible to the reader. The importance of rich contextual details has been thoughtfully described elsewhere (Eisner, 1990).

4. Consequential Aspects of Standards-Based Practice. Each case includes events that are relevant to teacher performance standards. These standards are not models, but frames of reference. The holistic nature of teaching implies that various standards will often apply and even overlap in the same case.


Elaine Temkin
Discussion Questions
Exhibits
Case Content Map
Explore Standards
Resources
Case Supplements
Where Am I?
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'Animated' narrative components

Provides topical overview of case

Commentary on reform and standards. Includes all Kentucky Performance Standards

Bibliography and a matrix of the CTC Case Series

Navigator to display Case Components

Online word processor where notes can be printed out

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Title:

Instructional Design Models and Research on Teacher Thinking: Toward a New Conceptual Model for Research and Development

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Introduction

Many instructional designers are concerned about the difficulties with disseminating Instructional Systems Design (ISD) models to teachers who are believed to be potential users of ISD (Burkman, 1987). Often lamenting that they do not seem to impact the public schools, instructional designers believe that exposing pre-service and in-service teachers to ISD procedures and products is a very important and first step in turning the situation around (Driscoll, 1989).

However, educational literature reveals few attempts to relate instructional design theory and methods to teaching practice. While research in teacher thinking presents a new image of teachers and teaching practice, very few of these findings are reflected in instructional design theories and models.

The purpose of this paper is to propose a new conceptual model for thinking about teaching that incorporates current findings of research on teachers' thinking and components of instructional design models and principles. The paper, therefore, will focus on reviewing the major findings of research on teacher thinking and instructional systems design. A conceptual model will then be presented to bring the two closely related fields together. The potential implications of the model for instructional development and research in instructional design and teacher thinking will also be discussed.

Instructional Systems Design Models and Principles

Instructional systems design draws its models and principles from a variety of disciplines mainly: general systems theory, communications theory, learning theory, and instructional theory (Richy, 1986). Instructional systems is defined as an arrangement of resources and procedures used to promote learning (Gagne, Briggs, & Wager, 1988). This definition uses the term instructional planning as a complete process of analysis, design, development, implementation and evaluation. A number of models have been developed by designers during years of instructional design practices (see Andrew & Goodson, 1980). Design models come from industry, education, the military branches, and a variety of other sources. These models define what should be and prescribe the necessary activities and sometimes prescriptions for effective instruction. Some of these models are called "conventional models" and focus on the instructional systems level with a closed system approach to design (Banathy, 1987). Complementary to the conventional (micro) instructional design models are macro-design or systems models that have a different purpose, different systemic characteristics, and use a different design approach. The purpose of these models is to provide societal-based systems and arrangements of learning resources and connect these systems and arrangements with the learning experience level of education.

Despite variability among different conventional instructional design models, they are all characterized by three key features: (1) a linear planning process, (2) an objective-first approach to planning, and (3) a generic model for planning instruction. These models usually begin with specifying instructional goals, developing a list of specific objectives, developing test items for each objective, and developing instructional strategies. After the implementation of instruction, the next step is to evaluate the plan to examine its effectiveness. The last and most important step is to review the instruction based on the performance information and to revise it as required.

The effectiveness of the different aspects of conventional instructional design models are supported by teacher effectiveness research and research on cognitive processes of learning. The effectiveness of an educational program that is designed by the complete instructional design models (macro and micro) has also been investigated and supported.

Instructional Design Models and Images of Teachers and Teaching

Since the establishment of the instructional systems design field, a major effort of experts in the field has been to use ISD models and principles to improve education at public school. Generally speaking, two approaches have been primarily used to disseminate ISD models in public schools. The first approach has been to provide school systems with systematically designed curriculum and materials to be implemented by teachers. The teacher-training programs and/or teachers' guides would be centered on the development of necessary skills needed by teachers to implement the systematically designed curriculum. This approach was primarily based on the designers' image of teachers as "delivery systems" (Tosti & Ball, 1969), which later changed to the image of "teachers as managers" (Taguchi, 1993).

The second approach centered on the idea of teachers as designers and developers of their own instruction (Taguchi, 1993). This approach aimed to empower teachers to be actively involved in their curriculum design. On the basis of this approach, teachers would design their instruction using fundamentals of instructional design models to plan, evaluate and modify instruction as a regular and on-going process and part of their classroom instruction (Dick & Resier, 1989).

However, none of the above approaches are found to be successful in disseminating ISD models and theories at public schools. Research on curriculum implementation showed that in spite of the designers' efforts at in-service and pre-service training, teachers failed to implement instructionally designed products (Back & McCombs, 1984, cited in Burkman, 1987). Although the researchers linked the lack of success to the poor dissemination efforts and lack of support for teachers who used the materials, critics questioned the assumptions that the teacher is a passive recipient of educational products, and that a technology of teaching is transferable from one situation to another. Research in staff development and teacher decision making also supported these suspicions (Posner, 1995).

While instructional designers had some success in providing training and practice in instructional design and theories in teacher education programs (Snelbecker, 1987), the available information on teachers and their use of instructional design practice is not encouraging either. Some of the research on teacher planning and decision making processes (e.g., Shavelson, 1983; Brown, 1988) reveal that teachers typically do not plan and provide instruction in accordance with procedures taught in teacher preparation programs. Yet, other studies have shown that experienced teachers do believe that rationale models are to be taught to novices (e.g., Neale, Pace & Case, 1983) and they do attend to learning outcomes, sometimes during teaching and sometimes after interactive teaching is over (McLead, 1981).

This discrepancy between teachers' non-use of systematic models and their favorable attitude toward them raises many issues regarding ISD models. A number of reasonable explanations have been identified. Educational technologists (e.g., Tessmer & Wedman, 1990) have begun to acknowledge the complexity of design and development processes, and they have described ways of adjusting this complexity to the contexts in which such processes are employed. However, despite the tremendous explosion of knowledge derived from research on teachers' thinking and teaching over the last two decades, very little of this emerging knowledge concerns ISD. As the gap between teacher-thinking research and instructional design models and principles becomes wider, the possibility that ISD models will be used in school systems becomes lessened.

In an attempt to relate findings of research on teacher thinking to instructional design models and practice, in the following section I present a synthesis of research on teacher thinking. I then use the findings of this research to propose a conceptual framework for thinking about teaching considering instructional design models and principles.

From Teachers as Decision Makers to Teachers as Sense Makers: A Synthesis of Research on Teacher Thinking

Much of the early research on teachers' thinking and decision making was based on an analogy between teachers' diagnoses and medical diagnoses (e.g., Barrows & Bennett, 1972; Elstein, Shulman, & Sprafka, 1978). It was believed that the major role of teachers was to diagnose children's difficulties and progress and, on the basis of the diagnoses, prescribe effective and appropriate learning tasks for them. This image of the teacher was influenced by theories in cognitive psychology, which in turn was influenced by a communication information-processing model. This influence led to research on teachers' thinking in 1975 that assumed parallel cognitive processes between teachers and physicians (e.g., Fogarty, Wang & Creek, 1982; Marland, 1977; Morine & Vallance, 1975). The main focus of many of these studies was on the structure and content of teachers' thoughts and sometimes their cognitive processes.

However, many researchers have sought to demonstrate a close parallel between teachers' thought processes and specific models of thinking, especially the decision-making model (Clark & Peterson, 1986; Shavelson & Stern, 1981). Early models of the decision-making process among teachers implied a linear course of action with alternative branches, which was very similar to the models of diagnostic problem solving in medicine (see Kagan, 1988). In general, this body of research has focused on cognitive processes, rather than on the more general knowledge which guides the practice of teaching in complex classroom situations (Borko, Livingston, McCaleb, & Mauro, 1988; Clark & Peterson, 1986; Marland & Osborne, 1990; Wood, 1988).

In the past fifteen years, researchers in the field of teachers' cognition have grown increasingly sensitive to the importance of classroom ecology in attempting to identify teachers' problem-solving strategies (Kagan, 1988). Once researchers began to look closely at the ecology of the classroom, it became clear that teachers work in a context that is complex in terms of multiple activities and continual, unpredictable change. Mechanistic decision-maker frameworks seemed inappropriate to explain how solutions were found for the myriad of complex practical problems continually confronting teachers within their classrooms and school communities (Carter, 1990; Johnston, 1993). The volume of differential knowledge and the rapid pace with which teachers must access this knowledge suggested a highly specialized form of clinical problem solving. Along with this shift, teacher cognition has developed into a wider concept of "teacher thinking".

Hence, in recent years the image of the teacher as decision maker has been replaced with an image in which "sense-making" is the central cognitive activity of teachers (Kagan, 1988; Clark & Peterson, 1986; NCRTE, 1988; Freeman, 1990, 1991). In this view teachers not only make decisions, but they engage in several activities, including decision making, in order to make meaning for themselves and their students (Clark, 1986). Thus, the metaphor of teacher as physician is giving way to the image of teacher as sense maker or reflective professional (Schon, 1983).

According to the metaphor of teacher as reflective practitioner, the problems of practice are messy, uncertain, complex and context-bound; and, therefore, teachers must resolve such problems by mentally experimenting and manipulating contextual factors, generating alternative hypotheses about the problem and mentally testing them in order to come up with a discovery that leads to action (Schon, 1987). This process of reframing (seeing the situation in a new way as a result of unexpected messages from practice) (Mumby, 1986), experimenting (generating hypotheses about the problem), acting (testing a new approach to practice) and reappraising is called reflection-in-action (Mumby & Russell, 1989). This image looks vastly different from the image of teaching as consisting of well-formed instrumental problems that can be solved by applying theory and techniques derived from previous research. Thus, professional practice is not "theory", but the process of developing and using practical theories of action.

The Idea of Professional Knowledge

It has been since 1975 that research on teacher thinking has emerged within the field of cognitive psychology. Two perspectives have existed on the concept of teacher knowledge: cognitive and epistemological. The advocates of the cognitive perspective believe that teachers are professionals who make reasonable judgments and decisions in a complex, uncertain environment (Borko & Shavelson, 1990). On this view, there is a relationship between thought and action. There is first thought, and then action. Two lines of research in the past decades have done much to enrich our understanding of teacher knowledge: expert-novice research and research on the content and domains of teacher knowledge.

Research comparing expert and novice teachers (e.g., Berliner, 1987; Greeno, Glaser & Newell, 1983; Larkin, McDemott, Simon, & Simon 1980; Leinhardt, 1983; Leinhardt, Weedman & Hammond, 1984) demonstrates that the amount of knowledge and the ways in which experts organize their knowledge is different from that of novices. Research on the content and domains of teachers' knowledge suggest different categories of knowledge. Shulman (1986a) emphasizes three (3) types of content knowledge: subject matter knowledge, pedagogical knowledge and curricular knowledge. Clark and Lampert (1986) mention three (3) categories of knowledge: contextual knowledge, subject matter knowledge, and knowledge of methods and inquiry. Research on teacher planning and interactive thinking is also seen as a means for organizing and transforming subject matter knowledge and curriculum into pedagogically useful forms of routine (Clark, 1986). Both the research on the expert-novice teacher knowledge and on the content and domains of teacher knowledge support the idea that teachers' knowledge and the way in which that knowledge is organized of crucial influence on teacher thinking and action.

The advocates of the epistemological perspective, on the other hand, believe that most of teacher knowledge will not be organized as knowledge, rather such knowledge is seen as personal and practical knowledge (Clandinin & Connelly, 1987) which is not solely cognitive in character. From this perspective, influence of the wider sociocultural system, coupled with the influence of the immediate learning environment, have the most contrasting effect on teachers' knowledge. Together with this wide concept of knowledge, the relationship between theory and practice has changed. Scientifically based knowledge is no longer considered the most important knowledge for teachers. Instead, the importance of experienced-based knowledge has been emphasized. This implies a transition from studying the relationship between teacher thinking and actions to studying teachers' actions as an expression of teacher thinking. Recent research on teacher thinking views teacher knowledge as an interpretive framework, or series of "implicit theories," by which teachers attach meaning to their environment and guide their actions within it (Clark, 1988; Calderhead, 1987; Zeichner, Tabachnick, & Densmore 1987).

The above concept of teacher knowledge used in recent research on teacher thinking is most developed by Schon's epistemology of practice. He uses the term "knowledge in action" or "reflection-in-action" to express the relation between theory and practice. The reflection-in-action epistemology suggests that teachers address problematic situations by recalling elements of similar past situations, selecting a move derived from a tentative interpretation of the present situation, attending to the "back talk" in reaction to the move and reframing or reinterpreting the situation (Schon, 1987). Schon's work has been very influential in validating a focus on the practical knowledge of teachers.

The current research on teacher thinking derived from Schon's epistemology of knowledge-in-action further emphasizes personal and practical knowledge (or pedagogical content knowledge) within a broader range of teachers' "professional knowledge". Teachers' professional knowledge goes beyond the classroom realities. It consists of knowledge of socio-political and contextual realities of school life. It defines teacher's personal and practical knowledge within a broader institutional context (Goodson, & Cole, 1994).

The Influence of Context

With the shift of metaphor from teachers as decision makers to teachers as sense makers and reflective practitioners, the dominant psychological epistemology of individual cognitive processing and technical action or knowledge being solely in the mind of the individual has been questioned (Gergen, 1985; Yinger & Hendricks-Lee, 1993). The immersion theory of situated cognition has changed the conception of thinking as a process within an individual's mind, perhaps influenced by a context provided by the situation, to the conception of thinking as an interaction between an individual and a physical and social situation (Greeno, 1989). Based on this social cognitive perspective, context influences knowledge structures, as well as beliefs and theories. Due to the situational aspects of the settings, a knowledge structure elicited from a teacher in one setting will not necessarily be the knowledge structure elicited in another setting (Roehler, Duffy, Herrmann, Conley, & Johnson, 1988). Teachers' professional behavior, therefore, always conforms to the structural, cultural and organizational context in which they work.

This view of knowledge shifted the focus of research on teacher thinking from the individual teacher's cognitive processing and technical action to the relationships between the individual and the context. As indicated earlier, what is learned by teachers is thought to depend primarily on what is provided, and how it is provided by the wider sociocultural system and the immediate learning environment. Knowledge is always marked by its situations-past and present use (Cazden, 1989). Moreover, the situations of classroom and school life do not produce the same responses in every teacher. The background differences that teachers bring to their classroom and school lead them to generate and organize knowledge in very different ways.

A more recent focus on teachers' lives and personal biographies consequently has conceptualized teacher development as rooted in the personal experiences (e.g., Bullough, Knowles & Crow, 1992; Butt & Raymond, 1987; Clandinin, 1986; Connelly & Clandinin, 1990; Knowles, 1992; Knowles & Holt-Reynolds, 1991). Other studies have argued for the personal mode as being linked to broader contextual parameters (e.g., Apple, 1986; Ball & Goodson, 1985; Britzman, 1986; Cole, 1990, 1991; Fox, 1992; Goodson & Cole, 1994; Goodson, 1989, 1988, 1989, 1990; Kelchtermans, 1993; Laffite, 1993; Zeichner & Grant, 1981; Zeichner & Tabachnick, 1985). This latter view stresses that teachers' professional behavior always takes place within the institutional context of a school. The teacher is a member of a team and is held accountable for his/her job by the principal and external bodies (Kelchtermans, 1993). It is true that there is a range of personal, practical and pedagogical knowledge that is important in understanding the teacher's conduct in classroom. There is also a range of knowledge of great importance that deals with the contextual realities of school life. This is critically important because it affects the lives and arenas in which personal, practical, and pedagogical knowledge are utilized and applied (Goodson & Cole, 1994). Events and experiences, both past and present, that take place at home, school and in broader social spheres help shape teachers' lives and careers.

Culture structures are general guidelines by which people ought to live. These general guidelines affect individuals' behaviors, their interactions with family and friends and even their approaches to education (Hamilton, 1993). The importance of social contexts (Dewy, 1904) cultural settings (Philips, 1983) and social construction (Berger & Luckman, 1966) in schools has been recognized for some time, and much research since that time has supported the importance and impact of the social contexts, cultural settings and social construction in the school arena. The culture of school shapes teachers' understanding of their own actions (Hamilton, 1993; Feiman-Nemser & Floden, 1986; Lortie, 1975; Sarason, 1982; Metrz, 1983, 1986; Rutter, Maughan, Mortimore & Oston, 1979) and that of their students (Tyler, 1987) and is grounded in faculty members' shared definitions (Page, 1988). Such understanding is also linked to a larger social class of the school and to the culture of the community.

Much research on teacher thinking within the paradigm of interpretive research has examined the connections between teacher knowledge and beliefs and their culture. Olson (1988) contends that ". . . . what teachers tell us about their practice is, most fundamentally, a reflection of their culture and cannot be properly understood without reference to that culture. . . ." (1988, p. 69). Cultural knowledge has been studied by looking at cultural patterns in teachers' life histories (e.g., Butt, 1984; Clandinin & Connelly, 1987; Elbaz, 1983, 1990; Richardson, 1989; Tobin, 1990; Wallace & Louden, 1992) and critical incidents in teachers' lives (e.g., Sikes, et al., 1985; Measor, 1985).

Thus a shift has emerged recently toward describing teachers' knowledge and practice, not only in the classroom context, but also within the framework that recognizes the influence of social and institutional cultures. Finding ways to connect teacher thinking and action with the context is the focus of this line of research on teacher thinking.

Toward a New Conceptual Model of Thinking about Teaching

Although research on teachers' thinking does not provide us with a comprehensive theoretical framework for thinking about teaching, a number of assumptions can be derived from research and theory in this field. These assumptions combined with the theories and principles of instructional design models provide a holistic picture that enables us to conceptualize the teachers' performance in the context of the classroom. The scheme proposed here (see Figure 1) provides a framework for thinking about teacher's, teaching or instruction. The scheme explains the major factors in teachers' thinking processes and assumed relationships among them.

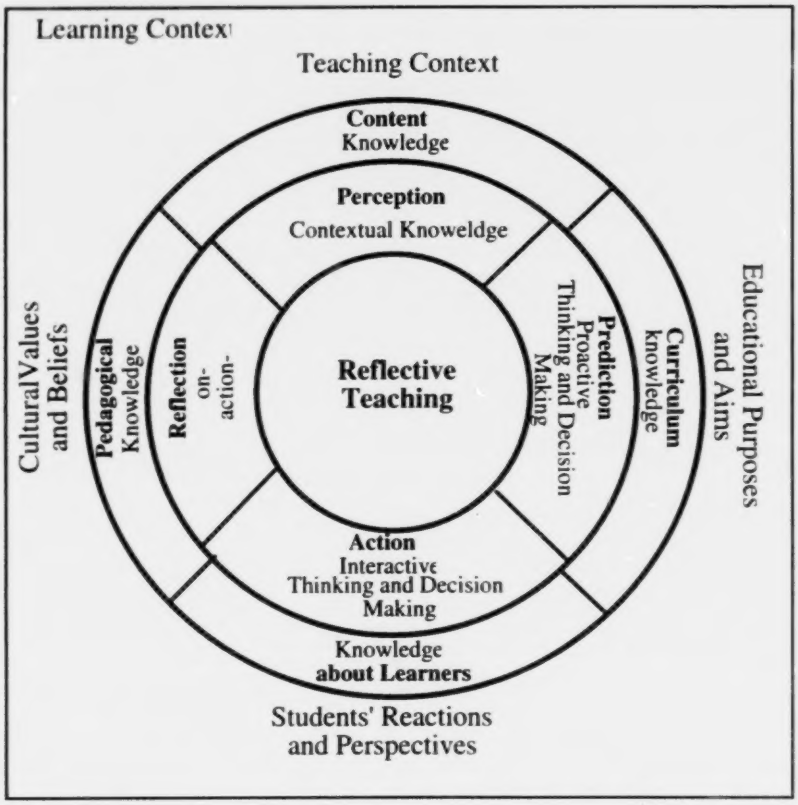
Learning Context
Teaching Context
Content
Knowledge
Perception
Contextual Knoweldge
Cultural Values
and Beliefs
Pedagogical
Knowledge
Reflection
on-
action-
Reflective
Teaching
Prediction
Proactive
Thinking and Decision
Making
Curriculum
knowledge
Educational Purposes
and Aims
Action
Interactive
Thinking and Decision
Making
Knowledge
about Learners
Students' Reactions
and Perspectives

Figure 1. Conceptual Framework for Research on Teaching and Instructional Design

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Three (3) basic characteristics define the proposed scheme. First, it proposes that teaching is a complex, highly contextualized profession, involving a complex form of social interaction that varies depending on context (Calderhead, 1987; Clark, 1986; Clark & Lampert, 1986). The relationship between teacher's thought and his/her action can only be described in relation to a specific learning and teaching context. By learning context we mean an environment where teachers, as learners, are part of a community that actively work together, and share the same social and organizational culture (Britzman, 1986, 1991; Fox, 1992; Goodson & Cole, 1994). Such context affects teacher knowledge and professional responsibilities by formal structure and pressures they exact on the teacher (Clark, 1986; Carter, 1990; Fox, 1992; Gudmundsdottir, 1991; Laffitte, 1993; Pope, 1993; Yinger, 1993). By teaching context we mean teachers, as learners, think on the spot, in relation to the context of the problem and the social climate of the classroom. Subject matter proficiency is not enough; teachers also need to see the subject in the way their students see it in order to transform that vision to benefit their students. Hence, what teachers do can never be comprehended solely in terms of teaching and learning academic subject matter. The formal curriculum of academic knowledge and skills has a counterpart "hidden curriculum" of values and behavior, which is embedded in the social and cultural systems of the school and classroom.

Second, teacher knowledge is grounded in a systemic and holistic notion of learning, knowledge, practice and relationships. It is constructed in the process of reflection, inquiry and action by teachers themselves (Schon, 1987), and it is used in complex ways during the process of planning for and executing teaching activities, as well as in making sense of decisions already made (Johnston, 1992). Knowledge consists of past construction (Fosnot, 1989). Teachers bring a set of predisposed and personal knowledge from their private lives to their practice of teaching (Johnson, 1989; Johnston, 1992).

Third, teaching is a dynamic, on-going, social and dialectical process which is intended to change (Calderhead, 1987). Change in the outer layers (teachers' knowledge and beliefs) is basically caused by the center of the cycle (teachers' reflective action), although the factors coming from one's interpretation of the context can also cause changes in the outer layers. Teachers' conceptions of the context in their professional world are important to consider when they try to change their teaching practice (Carlgren, Lindblad, 1991). The concept of the teacher's culture as a creative, historical system of symbols and meanings is also central to this change (Brown, et al. 1989; Yinger, 1990). The concept of culture is not limited only to verbal expression. Both verbal and nonverbal communication are culturally patterned even though the teacher may not be aware of it. The meaning the teacher gives to his/her experiences (actions) differs from culture to culture. In other words, the way a teacher of a particular culture (e.g., gender, ethnicity, class) categorizes and interprets his/her actions may be different from the way another teacher from another culture would view them.

Figure 1 also shows the basic elements of teaching and teachers' cognition. According to this framework, in order to explain teachers' behavior, it is necessary to look at the classroom as a social and cultural system characterized by reciprocity among participants and between the participants and the physical setting. The basic elements of teaching are the teachers' knowledge, beliefs and perceptions of their craft, which incorporates various students' reactions and perspectives. Skill in teaching rests on teachers' knowledge, which can be divided into pedagogical content knowledge, personal knowledge, knowledge of curriculum and knowledge about learners (Clandinin, 1986; Shulman, 1986a). Teachers' knowledge and beliefs move in a spiral toward more concrete levels of knowledge, which are prediction, action, and reflection. There is a direct relationship between teachers' knowledge and beliefs, and the way they interpret their practice, although much of the knowledge that teachers hold and act on is tacit. The beliefs, values and norms that teachers come to have the most faith in and use most frequently to guide their practice are those consistent with predictions that have "worked" in the complex and demanding classroom arena (Clark & Yinger, 1987). While teachers' preactive plans (predictions) provide frameworks for what is possible or even likely to occur in classrooms in practice, these frameworks do not function as rigid scripts for teacher activity. Instead, in the interactive process of teaching in which cognition is translated into action, teachers engage in moment-to-moment decision making and problem solving based on their perceptions, practical knowledge and judgments about the events. Teachers' metacognitive, purpose-driven behavior and/or reflection on the effect of an action helps them modify their previous pedagogical concepts or build a new pedagogical principle which, in turn, affects their future thinking, planning and action.

Implications of the above Conceptual Model for Research and Instructional Design Practice

The above conceptual model proposes several changes in the ways that research has been conducted in this area. First it suggests that teachers and their teaching and learning processes can only be studied within their social and cultural context. To understand why teachers do what they do, researchers need not only to focus on the present social context of teaching but they also need to consider the historical and organizational context in which teachers have worked for years. Within the historical context of teaching, teachers' life history, as a social context of their beliefs and culture is of particular importance.

The above conceptual framework also suggests that teachers' knowledge is a complex blend of personal, practical and theoretical knowledge . What teachers do is a reflection of this complex and highly social organization of knowledge and cannot be studied without gaining access to them. Research in teaching, learning and instruction, therefore, has to shift its emphasis from cognition to social construction of knowing.

The above model also suggests some changes in instructional design models and principles. First, the image of teachers as designers of their own instruction needs to be emphasized in the instructional technology field. However, the instructional design models and principles should be reconceptualized if they are to be used by teachers. The instructional design models and principles are to consider the social context of learning and teaching. The new conceptualization of the design processes should focus on the decision making processes that can describe the complex, uncertain and content and context-bound approach to instructional design. This new conceptualization should then consider several issues with regard to the concept of design in real-world settings: the context or environment of the design, the experience of the designer and his/her frame of reference, the content specific characteristic of the design, and finally the interactive and dynamic nature of the design activity. Each one of these issues should be further investigated and incorporated in the conceptual theory of instructional design.

Second, the concept of design as an artistic, social and cooperative act should replace the procedural and technical concept of design. Instructional design activities should be focused on the product of the design instead of focusing on the procedure. Once the design is conceptualized as an integrated and systemic (holistic) approach that can only be improved through constant and continuous reflection, different instructional design techniques or procedures (analysis, design, development and implementation and evaluation) can be seen or isolated as significant skills to improve teaching performance or developed instructional product. An integrated and systemic approach to instructional designs allows the teacher designer flexibility of the design and emphasizes the teacher designer's interpretations of his/her performance with respect to instructional context.

Finally, instructional design models and principles should focus on an approach in which the design objectives and strategies or solutions evolve as the teacher designer becomes more acquainted with the social and cultural system and subsystems. It should also take an approach in which people who are affected by the design, including learners, are actively participating in the decision making process. The participatory, dialectic and evolving design approach that focuses on the process of negotiation is a form of design that integrates the four familiar phases (analysis, design and development, implementation and evaluation) of instructional design models into one activity. It seems that a cognitive, objective and systematic (step-by-step) approach to designing instruction should be reconsidered if instructional design models are to be used by teachers.

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Title:

Technology Resource Teachers: Is This a New Role for Instructional Technologists?

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Introduction

For decades, skills in instructional design and technology have not been tapped by public schools. One resource that has been consistently overlooked in public school systems is the pool of educators who have been trained in instructional design and technology. Even in the educational technology field, little attention is given to the role that instructional designers/technologists can play in solving the problems facing the schools, including integration of technology into classroom practices. Instead, the emphasis has been on increasing the extent to which computers are used for instructional purposes. It is optimistic to assume that the increased use of computers in schools will necessarily result in properly integrating technology into instruction to improve students' learning outcomes. Professionals in the field agree that the value of learning technology is actually dependent upon what use we make of them.

Leaders in the field of instructional technology seem to loose hope of getting instructional designers/technologists into school systems in order to help teachers to properly design their curriculum while integrating new technology (Reiser, 1988). Hence, most professionals in the field focus their attention on business and industry. Others have tried to influence classroom instruction by developing instructionally designed software for classroom instruction and/or developing automated instructional design software for teachers (Merrill & Li, 1988, 1989). Still others place greater emphasis on preservice teacher education programs to prepare teachers to learn not only how to use technology, but also how to integrate it into their instruction (e.g., Dick & Reiser, 1989; Reiser, 1988; Reiser & Dick, 1996; Rosset & Garbosky, 1987; Sullivan & Higgins, 1983; Zellner & Rieber, 1991). There has also been strong support for school restructuring initiatives among leaders of the field. Proponents of systemic change in education believe that the existing system is outdated and is no longer serving the needs of learners (Mory & Salisbury, 1992; Reigeluth, 1992; Salisbury, 1993). Therefore, they suggest to replace the existing system with one which is more appropriate to the needs of students in the twenty-first century.

While educational technologists are trying to find ways of becoming more involved in solving educational problems, school systems, under pressure for reform and accountability, have begun to use their technological resources to ensure increased academic outcomes of today's diverse student population. Lamenting that previous educational media such as language arts labs, closed circuit television, and movie projectors yielded less than the anticipated results in public schools and that microcomputers are almost meeting a similar fate, it seems that school systems are beginning to realize that the problem is more instructional rather than technological. Emphasis of many school reform initiative plans for the integration of computers into classrooms across the curriculum (e.g., Levy, 1986; Mergendoller & Pardo, 1991; Sanacore & Alio, 1989) is one example of these efforts. Another example is public schools' attempt to establish a technical and instructional support system at the school level to assure the proper usage of the technology, mainly computers. This attempt resulted in the creation of a professional job position that seems to go beyond utilization of media and library resources. The fact that a technology coordinator or the Technology Resource Teacher is assigned to this position in several states, districts, and/or counties demonstrates public schools' desire to focus on integration of technology into classroom instruction. But, how successful they are and whether or not they are achieving what they desire to achieve has not been studied.

It appears that the instructional designers' expertise is needed more now in the public schools than any time before. It is obvious that if schools are to look beyond the number of computers and their usage, an instructional support system is needed to help teachers design their instruction in a way that new technology is an integral part of it. The questions are raised: Do the school systems consider or mention instructional designers/technologists as a solution to their problems? Will they ask for the instructional designers/technologists' help in the future? Experience shows that the answer to this question is "No". However, very few researchers have tried to empirically find those conditions under which instructional designers or technologists may be best involved in the integration of technology into classroom practices. It is not hard to anticipate that, given emerging technologies and the increasing demands and needs for integration of these technologies to the classrooms, the field of instructional technology can provide the best instructional support for teachers and the means by which to keep them updated.

The Purpose of the Study

In an attempt to respond to school reform initiatives and a State-mandated use of computers in the public school classroom, one school district located in southeastern North Carolina began to implement a computer competency program in the local elementary, middle, and high schools beginning in September, 1994. This program was to be integrated into the classroom curriculum in such a way that the focus was not merely on the operational use of technology, but on the use of technology as a tool to facilitate students' learning by using technology to generate ideas and access information. To reach this goal, the teachers are expected to design and implement instruction in a way that technology is a part of their classroom practice. Thus, teachers need not only to have skills in operating and using technology, but also to have skills in designing, developing, implementing and evaluating curriculum and instruction which integrate different technologies and delivery systems.

Most teachers in the county do not possess skills to use technology in their classrooms, nor do they know how to integrate the technology into their instructional practices. To begin this educational process, the school district has recently hired thirteen Technology Resource Teachers to support and facilitate integration of technology into classroom teachers' instructional practices. Some of the resource teachers have been in their schools for several years, and were reappointed within their school to be full-time technology educators.

The purpose of this study was to explore the roles and responsibilities of these Technology Resource Teachers ("TRT") and the effects that their roles have on the integration of technology in classroom instruction. The study also sought to examine: (i) how Technology Resource Teachers' roles differ from those of instructional designers and technologists if they were to be involved in public schools, and (ii) what an instructional technologist might do if he or she was assigned to this position. The study, therefore, focused on the following specific questions:

- What are the roles and responsibilities of these educators?
- What role and expectations does the district have for these educators and how are these roles and expectations being fulfilled?
- Do the resource teachers possess the skills and knowledge required to successfully play their role? If so, how did they acquire those skills and knowledge?
- How do the TRTs affect integration of technology into classroom practice?
- What kind of skills and knowledge does a teacher have to possess to be eligible for being a TRT?
- What are the differences and similarities between the TRT and an instructional designer/technologist?
- Would the role of the TRT propose a new set of competencies for instructional designers/ technologists who want to serve the school system?
- How are these competencies different from those of a media specialist?

The Research Method and Its Framework

A naturalistic and participant-oriented model within the paradigm of naturalistic studies was used for conducting this exploratory study. This approach was perceived to be appropriate because it could help researchers describe the program holistically and understand it from the perspective of participants. It also provided enough flexibility to base information on program activities rather than on program intent. It also made it possible to employ multiple data-gathering methods, especially observation and interviews. Rippey (1973) suggests this approach for understanding the process of change in various types of organizations.

The following data-collection methods were used in this study:

- informal and formal interviews,
- classroom, workshop, and site observations,
- public and personal records, reports and documents,
- questionnaire and attitude surveys, and
- focus group discussion.

Due to the limitation of time and resources and because the program was first conducted at the middle school level, the present study focused only on middle schools in the county (six in total). The data collection began in early January, 1995 and continued until early December, 1995. From January to March, 1995 the study focused on gathering preliminary data about the program, conducting interviews with the Technology Coordinators for the county, reviewing documentation on the roles and responsibilities of the TRTs, as well as documentation on the whole program, and visiting each of the sites.

From March to May, 1995, interviews were conducted with the TRTs, their classroom and training workshops were observed, and attitude and general information surveys were administered to teachers on each of the sites being observed. The general survey was constructed by the researchers around the major questions of the study. A Computer Literacy Attitude Survey ("CLA") was also adopted and completed by the teachers at each site. (Both of these surveys may be viewed in Appendix A.) Both survey instruments were completed by teachers following one of the school's professional development meetings upon the request of the respective Technology Resource Teacher.

The General Information Questionnaire consisted of 18 closed-ended and nine open-ended items. The closed-ended items asked about teachers' computer facilities at home and the classroom, their usage of their computer facilities, their previous and present computer training, the computer competency tests, and their feelings about their computer skills. The open-ended items, on the other hand, asked teachers about their perception of the role and responsibilities of the TRTs, and the nature of the help that teachers receive from the TRT in their respective school. The CLA survey consisted of 50 Likert-scale type items which were developed and used by Savenye and her colleagues (Savenye, 1992; Savenye, Davidson, & Orr, 1992) to measure attitudes of preservice teachers toward computers. The items were slightly modified to be used with in-service teachers. In addition to the Likert-scale items, teachers were asked several questions about their background and the number of hours that they had participated in computer training workshops. The return rate for both the general survey and the CLA survey was between 90-95% for two of the schools and was between 55-71% for the other four schools.

During the 1995 fall semester, interviews were also conducted with the principals of the schools, and a focus group discussion was conducted with the technology coordinators of the county. All of the interviews and focus group discussions were audio-taped and transcribed for further analysis. Field notes were used for recording observation data and informal interviews.

Data Analysis

Data were analyzed using both qualitative and quantitative analysis techniques. Interview and observation data, the results of the open-ended questions from the general survey, and the collected documents were analyzed qualitatively using the Miles and Huberman (1984) model. Based on this approach, the first part of the analysis was data reduction. During this process, the data chunks were identified and coded, the patterns that best summarized a number of chunks were sorted and then were further subsumed into larger patterns. In some cases, the data were organized using the frequency of the responses to specific questions or by the pattern of responses. In such cases, however, the numbers were used together with the words to keep the data in its context. During the second analytical stage, the data were summarized and organized using matrices, charts and tables. This stage helped the researchers interact with the data and draw their preliminary conclusions, which in turn went through another round of testing and verification using all different sources of the data for the final conclusion.

The results from the closed-ended items of the general survey and the attitude questionnaire were analyzed quantitatively. Descriptive statistics, cross tabulation, Pearson correlation, and MANOVA were the quantitative techniques that were used for this part of the data.

Results

Description of the School District and the Technology Initiatives

The study was conducted in all of the middle schools (a total of six) within a city district in the northeastern United States. The district is within a zone that draws from affluent neighborhoods, as well as from neighborhoods of racially- and ethnically-mixed working- and low-class families.

In 1992, the State of North Carolina Department of Public Instruction put together a set of computer skill competencies as a basic requirement of public school students and teachers. In anticipation of this state technology initiative that requires all schools to integrate technology into their classrooms and all teachers and students to pass a technology competency test, the district technology coordinators had to design a plan that would enable the classroom teachers in the district to begin to attain these computer skills. While the elementary schools in the district already had a designated classroom teacher to act as a technology resource person, and the classroom teachers were already using technology in the elementary classrooms to some degree, the middle schools in the district were not set up with such a situation. Since the mandate included a timeline to eventually administer a test to all eighth graders in the state, insuring that students had met the minimum computer skills, it was imperative that the middle school teachers and students be targeted for broader technology support.

The TRT position was created to provide technical and instructional support at the school level to help teachers integrate technology into their curriculum and classroom practices, and to assist teachers in passing the technology competency test required by the state. This position was created to be different from the media specialist position which already existed in most schools. The role of the TRT differs from that of the media specialist because the TRT was expected to be responsible for integration of computer technology into classrooms, while the media specialist was responsible for library media and providing print and media support at the school library. Two technology supervisors at the district level were in charge of developing a job description for the TRT position and helping principals hire the qualified individuals. These two supervisors were also in charge of preparing the TRTs for their job responsibilities by providing them with training workshops and proper technical and administrative support.

The Technology Resource Teachers: Who They Are and What They Do?

Six technology resource teachers were interviewed in this study. Their educational background spans from one year of previous teaching experience to twenty-two years of previous teaching experience. The majority of them have a background in teaching math (83%) and/or science (16.7%). Four of the TRTs were classroom teachers in their respective schools before being appointed to this position. Two of the TRTs were hired from outside the school and were new to the school as well as to the appointed position. In general, the TRTs' background in computer training incorporates college courses and in-service training workshops (50%), job related experiences (33.3%) and self-learning/practices (16.7%). Each of the TRTs have passed the computer competency test required by the state. Their reasons for becoming TRTs include an interest in technology and an interest in teaching. None of the TRTs, however, have had any training or college courses in instructional design and technology. They also have not had any training and/or experiences in analysis, design, development and/or evaluation of instructional materials and/or programs.

The observation, interview and questionnaire data show that all six TRTs have formed the computer lab at their school and have maintained its operation throughout the year. They have used the computer lab to teach technology skills to the teachers and to the students in their schools . The main focus areas in workshops are: database, word processing and spreadsheets. Terms and operation, keyboarding, societal uses, and ethics have also been taught. Teachers at each school then were given the choice of attending the training workshops provided at their site or other schools. Since the response rate was not equal for each school, a random sample of 17 responses was selected from each school for further analysis. A chi-square test of difference between the number of training workshops provided by each school (after equalizing the sample size across the schools) shows that teachers in each school have received equal number of training workshops (see Table 1). This result, combined with the observation and interview data, indicates that all six TRTs provided similar hours of training workshops for teachers in their respective schools.

However, the analysis of data from different sources, including the general survey, suggests that more teachers in School 2 were able to take the computer competency test in all five areas (see Table 1). School 1 rates second with respect to the number of teachers who were able to take competency tests in all areas, except for keyboarding. Data shows that the teachers in School 2 and School 1 do not rate their computer skills significantly higher than the other schools. In some areas, such as word-processing, keyboarding and spreadsheet, School 2 and School 1, in fact, rate their computer skills lower than School 3 (see Table 2). Also, the teachers' previous experiences with computers in School 1 and School 2 are not significantly different from the other schools (see Table 3). In fact, teachers in School 1 ranked second lowest with respect to their previous experience with computers. Analysis of qualitative data provides an explanation for these results. The TRTs in both School 2 and School 1 emphasize their role in helping teachers pass the technology competency test, while the other TRTs do not identify this role as their major responsibility (see Table 4). Teachers' perception of the TRT's role and responsibilities in School 2 and 1 suggest that this emphasis by the TRT in helping teachers pass the technology competency test has obviously been communicated to the classroom teachers, possibly during training workshops and/or during implementation of other teaching strategies.

In addition to providing training workshops, technical support, and troubleshooting, the majority of TRTs attempt to help teachers develop lesson plans that integrate computers into instruction using word processing, spreadsheets, database and other educational software (see Table 5). The TRTs' primary instructional strategy for accomplishing this goal is to model the teaching of the various computer competencies to students through an integrated lesson within different subject areas (e.g., language arts, mathematics, social studies, and science).

> . . . .Well anything like this lesson that I have created. We will actually do this lesson at our workshop. . . .A lot of what I do with the kid I lead the teachers through first. (TRT School 2)

> . . . . When they come to the lab even though it is a generic lesson, it is oriented to some subject. It is database on planets or a spreadsheet on nutrition, so I think they can see that there are ways to do this, but we just have to make it specific to what they are teaching in the classroom. . . . (TRT School 5)

> . . . .If I have to pull them in there, they will use it. You know once they see how it can be done, then they will be more willing to do on a more regular basis. . . .Whenever I come up with something I go to them. . . . (TRT School 1)

The integrated lesson in most cases is taught by the TRT, while the classroom teacher is also present to help or to observe. In a few cases, the teachers themselves teach the integrated lesson while the TRT is present to help.

All TRTs indicated that their immediate goal with respect to their role at the school is to bring technology to teachers and students and to make them feel comfortable with technology.

> . . . .I think my role is to prepare students and teachers for computer usage. (TRT School 2)

> . . . .Well, have a very good impact on teachers' use of computers. (TRT School 6)

> . . . . To set computer lab and be able to provide technical and instructional support. (TRT School 3)

> . . . To be able to provide technical support and comfort teachers to use computer. Also help teachers and students in their computer skills for computer competency test. (TRT School 1)

> . . . Get teachers to come to computer lab and provide technical support. (TRT School 4)

They also infer that their long-term goal is to help teachers integrate technology into their classrooms and for the respective subject teachers to assume the responsibilities of preparing students for computer usage. None of TRTs seem to have specific short-term or long-term performance objectives and/or expectations for teachers and/or students at their respective schools. The mandated state competency exam seems to have driven both their activities and workshops at the schools.

Q: Do you have specific goal or objectives for this year?
My aim is to get a support system in place, and by that I mean my teachers need to have basic skill so that when we bring the students in here, two of us know the skills and could answer the questions. . . I want to get as many of them passing the test and having success with the test. . . .(TRT School 2)

I think getting with the teachers in their planning periods. If I can sit in with them, seeing what they are doing, finding out their problem areas, maybe I can enhance their problem areas of how they teach a lesson. But I think basically working with them. (TRT School 3)

We started off with the operation and care and keyboarding because they are just basic information about the machines. We have now moved into more complicated item types such as database and spreadsheets. In our school we emphasize on computer competencies. . . .
(TRT School 6)

As indicated above, upon establishing the computer labs at their schools, all six TRTs began to provide computer training workshops for teachers. However, interview and observation data show that none of the TRTs attempted to conduct a formal needs assessment to identify the areas of needs for training. While one may assume that technology coordinators at the district level have already identified the needs and the problem areas at each school, the interview data with the coordinators do not provide any evidence for this assumption. The majority of TRTs, however, did indicate that they already knew the areas of needs in their schools due to their familiarity with the school and due to their close relationship with the teachers. Two of the TRTs also indicated that they administered a survey at the beginning of the year to get a sense of the teachers' perceptions about their knowledge and skills in the different computer competency areas.

All TRTs also established an hourly computer lab schedule for their schools. This schedule is used to encourage classroom teachers who want to bring their classes to the computer lab to arrange the time to do so. The TRTs seem to use the computer lab sign-up sheet to identify the teachers who have begun to think about integrating computers in their curriculum. A few of the TRTs also keep a sign-up sheet for the teachers who attend the training workshops in order to monitor the hours of training workshops that each teacher completes. However, none of the TRTs seem to use a formal and continuous monitoring process for identifying the teachers' progress; nor do they use any method for identifying the effectiveness of the strategies that they have employed to encourage teachers to integrate technology into their curriculum. Again, it seems that the number of teachers who are able to pass the computer competency test is an implicit indicator of success for both the TRTs and the technology coordinators at the district level. Nevertheless, all TRTs seem to informally monitor the teachers' integration of computers into their curriculum.

The Role and Responsibilities of Technology Resource Teacher: What are They Expected to Do and How Do They Perceive their Job?

Tables 6a and 6b summarize the data from different sources regarding the roles and responsibilities of the TRTs. As Table 6a indicates, the job description of the TRT describes the instructional, technical and administrative dimensions of the job. A content analysis of the job description also reveals that the instructional aspect of the position is emphasized more than the other two aspects of technical responsibilities and administrative responsibilities (8 statements on instructional responsibilities as opposed to 4 statements on technical responsibilities and 5 statements on administrative responsibilities). The list of job qualifications also requires TRTs to have a minimum of three years teaching experience. Thereby, indicating the pedagogical importance of the position.

Table 6a also summarizes the perspectives of the middle school principals and the district technology coordinators about the roles and responsibilities of TRTs. While the job description and qualifications for TRTs emphasize the instructional importance of the position, both the principals and the technology coordinators indicated the technical and interpersonal skills of TRTs to be the major factors for the selection of the individuals for this position. The majority of the principals, however, point out that they preferred to select one of their technically qualified teachers at the school for the position, if one existed, instead of hiring someone from outside of the school. Their reasons for this preference include the easier transition process and the familiarity of the TRT with the school's staff and its context.

TRTs were also asked to describe their perceptions of their roles and responsibilities. Table 6b summarizes the statements that are used by each TRT to describe their job. As Table 6b suggests, while there are some differences in the perceptions of each TRT of their roles and responsibilities, the majority of TRTs (83%) agree on the fact that they spend 70% or more of their time providing technical assistance and support (e.g., setting and maintaining the lab, troubleshooting, installing software and hardware) and only 30% or less of their time providing instructional support. This is why they believe that they should have spent the majority of their time providing instructional support. Table 6 also lists the common statements that teachers at different schools use to describe their perceptions of the role and responsibilities of the TRT. Although there are some differences in the perception of teachers in different schools (see Table 4), it seems that teachers generally perceive the TRT as providing more instructional support than technical support. There are also commonalities between the TRTs' perceptions of their own roles and responsibilities and the teachers' perception of the TRTs' roles and responsibilities. For example, the TRT in School 3 perceives self as a technical support. This perception is consistent with the perception of the classroom teachers in this school that indicate technical support as the major role of the TRT. The TRT in School 2 perceives the TRT role as helping teachers and students to pass the computer competency tests. Teachers in this school also perceive the major role of the TRT to be in training them for the computer competency tests.

The Role of Technology Resource Teachers in Integration of Technology into the Classroom

How do teachers use technology? The results from the general survey show that more than 50% of teachers who responded to our survey have a home computer, 60% have had previous computer courses or workshops, more than 47% have had between 40 to 20 hours of computer workshops at their school, and 81% have a computer in their classroom. A chi-square test of categorical data showed no significant differences between schools with respect to the above variables (n=17).

The analysis of teachers' responses to open-ended questions in the general survey reveals some useful information. While usage of computers varies slightly from one school to the next, the majority of the teachers who are using their classroom computers indicate that they are mainly using word-processing and subject-matter software (see Table 7). Enrichment/remediation and keyboarding rank next as the third and the fourth most common applications of the computer usage in the classroom. This result is consistent with the result of the closed-ended items which asks a similar question. The highest percentage of classroom computer usage is for remediation and enhancement of students learning. Preparing hand-outs and other visual presentation rank as the second and third forms of classroom computer usage (see Table 8). The interview and observation data also reveal that word-processing, games and subject-specific software for remediation purposes are those areas of computer application primarily used by students when teachers and students are using in computer labs.

Table 2 also shows that teachers across different schools rate their word processing skills as the strongest computer skills, while they rate telecommunications as their weakest computer skill area. (There were no significant difference among the six schools on this variable). Comparison of this result with the above outcome attests that teachers are using computers in their classrooms in the areas that they have acquired the skills and knowledge to do so.

Analysis of interview data also indicates that while a number of teachers at each school responded favorably to the TRTs' initiatives to use the computer lab for an integrated lesson, the majority of teachers are still at the starting point with respect to both computer usage and the integration of computers into their curriculum.

> This has probably been harder to convince people that it is possible. I think a lot of that is a function of teachers' skill level. I feel like I have been really successful in some situations because teachers were just open and wanting (TRT, School 6)

> A lot of teachers are coming in (lab). . . . they are sending interim reports on the computer. I see a lot of that type of things going on. (TRT, School 2)

> Some are doing it now. I have got some that are just wonderful. They do a good job with it now. Others I think it is just a matter of they need to be shown what to do with it. They are so used to doing their own things that it would be hard to do something else. (TRT, School 1)
>
> There are some folks that would like to work with it (computers) but still hesitate to do things on their own. So I have to go and pull them in. Sometimes you just have to go and say, "I think we can do this." They don't know what they can do. (TRT, School 3)

As the above excerpts show, the TRTs think it will take time for teachers to learn how to integrate computers into their curriculum. The major problems that TRTs see with respect to teachers who are reluctant to use computers are: not enough time to learn about computers, not knowing the application(s) of computers in their subject matter area, and not seeing the benefit of computer programs for students' learning. The majority of TRTs believe that all of the above problems can be solved by informally approaching teachers and helping them plan an integrated lesson and implement it successfully.

Teachers were also asked to explain the reasons they selected certain computer skills as their weakest areas. The majority of teachers indicated that they need more training, time, and opportunity to practice the skills that they have learned in order to be able to use computers in their classroom (see Table 9). This is their perception, although at the time of the survey, 47% of teachers had already completed 20 to 40 hours of computer workshops and 81% had taken previous computer courses. From these figures and the above findings, it appears that training workshops are only the beginning point for most teachers. In order for teachers to use computers and integrate them into their curriculum, they need practice over a long period, as the TRTs pointed out.

How do teachers feel about technology? A total of 206 teachers across schools completed the CLA survey at the end of the 1994-95 school year. This was after having TRTs in their respective schools during that year. The survey contained items related to liking computers, valuing computers for society and education; anxiety about using computers; confidence with regard to learning and using computers; and perceptions of gender appropriateness of computers. Teachers were asked to rate the items from "Strongly Agree" to "Strongly Disagree". In addition to Likert-scale items, teachers were also asked several background questions. A summary of the responses to these questions is presented in Table 10.

The results of attitude survey show that teachers have a fairly positive attitude toward computers. Appendix B summarizes the means of all teachers responses to Computer Attitude Survey. As the means scores shows teachers seem to like computers, value computers for education and society and have confidence about learning and using computers. However, they still have some anxiety about computers (Average M= 4.00 where 5=Strongly Disagree). A repeated measure of attitude is required to determine any changes in teachers' attitude over time.

A correlation analysis of different items related to liking computers, valuing computers for society and education, anxiety about using computers, confidence with regard to learning and using computers, previous experience with computers, ratings of computer skills at present and before the school year, and current usage of computers in the classroom revealed some interesting findings. Tables 11 to 16 summarize the results of this analysis. As these tables show, teachers who rated their computer skills higher, liked computers more, had more confidence for learning computers, valued computers for the society and education more than others, and had less anxiety about using computers. Findings also showed correlations between confidence for learning computers and the level of anxiety for using computers. Teachers who felt more confident learning and using computers tended to have less anxiety for computers. Teachers who had previous experience with operating computers also showed more confidence for using computers. Table 16 shows that teachers who had completed more hours of training workshops tended to rate their computer skills higher than others.

An analysis of multivariance was also conducted to investigate the combined effects of different categories of attitude toward computers at different schools, the usage of computers in the classroom, different levels of previous computer experiences, and different levels of computer skills. Since the response rate was not equal for each school, a random sample of 24 responses was selected from each school for this analysis. Tables 17 through 21 show the means and standard deviation for each dependent variable. The result of the multivariate tests are also presented in Table 22. As Table 17 shows, the difference between schools across variables such as liking computers, value for computers in education, confidence for learning and using computers, and anxiety for computers is not significant.

We also investigated the combined effects of the above variables represented in the attitude survey on the current usage of computers in the classroom. Table 18 shows means and standard deviations for each dependent variable. The results of a multivariate test is also presented in Table 22. As the table shows, the difference between the teachers who are currently using computers and the teachers who are using computers across different ?? attitude measures was significant. The univariate test shows that teachers who are currently using computers in their classroom, like computers more, and value computers for education more than those who are not using computers in their classroom. The anxiety and the confidence for using computers is not, however, significantly different for those who are using computers in their classrooms and those who are not using computers in their classrooms.

Table 22 also shows that there is a significant difference between teachers who had previous experiences with operating computers and those who did not on categories such as liking computers, confidence for using computers, and anxiety for computers. In other words, teachers who had over a year of previous experience with computers liked computers significantly more, had less anxiety toward computers, and had a higher level of confidence for using computers than those who had no previous experience (see Table 19). However, this difference was not significant for categories such as value for computer in education and confidence for learning computers.

Finally, as presented in Table 22, there was a significant difference between the attitude of teachers toward computers (on all categories except for the value for computer in education) and the level of computer skills. In other words, teachers who rated their computer skills highest before and after the school year liked computers more, had more confidence learning and using computers, and felt less anxiety towards computers (see Table 20 and 21).

In sum, although the statistical analysis of the attitude survey revealed some very interesting results, it failed to demonstrate any significant differences between attitude of teachers toward computers at different schools. Usage of computers in the classroom, previous computer experience, and skills in using computers are identified as factors that had effects on teachers' general attitudes toward computers.

Discussion

This study has been conducted to explore the roles and responsibilities of the TRT, and the effects that the TRT's role has on the integration of technology in the classroom. It also sought to examine how the TRT's role differed from that expected of instructional designers/technologists, if they were to be involved in public schools; and to explore what an instructional technologist would have done if he/she was assigned to this position.

The study showed that the role and responsibilities of TRTs are primarily instructional, although technical and administrative responsibilities are also expected. Excellent communication skills, the ability to understand the dynamics of teaching and the role of teachers, and being able to work closely with the classroom teachers appeared to be vital characteristics contributing to the success of the TRT, particularly as they affected the classroom teachers' acceptance of and openness towards the technology. In addition, familiarity with the school context appears to enhance the readiness for success, both through the TRT's ability to understand and analyze where the teachers' progress lies, and through the classroom teachers' comfort level for working with the TRT. Although the TRTs estimated that they spent around 75% of their time on technical support and the county administrators expected a high level of technical expertise in the requirements for selecting a TRT, the study indicated that the nature of the TRTs role was more instructional than technical. For example, the teachers' expectations of the TRT was one of instructional support through training, workshops, and demonstration of the applications of the computer. Furthermore, the TRTs felt that their next phase would result in much less technical work and much more instructional work in the integration of technology into the classroom.

As an instructional support system, each TRT used some strategies to help teachers in his or her school integrate computers into their curriculum. Although TRTs' instructional strategies were somewhat different, their primary

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instructional strategies were: providing training workshops, teaching integrated lesson to students while teachers were present, approaching teachers informally to help them and give them new ideas, and encouraging teachers to schedule their classes for the computer lab. However, while teaching computer skills to teachers and students was the TRTs' major instructional activity, the findings of the study indicated that TRTs did not conduct a needs analysis at the school. They did not prioritize the needs, they did not have specific objectives, nor did they have a planned action for implementation and evaluation. Instead, they applied an intuitive and informal understanding of the needs to initiate the strategies or support. They provided training workshops based on their own understanding of the teachers' needs, informally monitored the process, and used more of the collegial relationships with teachers to help them integrate technology.

As an instructional designer, when one approaches the task, one approaches it first by identifying the problem through a formal analysis of needs to determine if there is an instructional solution to the problem. Instructional designers then proceed with the design of instruction to meet the needs of the learners, monitor the process, evaluate the results, and revise, if necessary. While it is premature to determine if TRTs' strategies for helping teachers integrate technology was effective, data show that the TRTs are able to develop a rapport with teachers which enabled teachers to feel comfortable working with the TRT, working in the computer lab, and to more willingly approach utilizing technology in their instruction.

Had the TRTs been trained in the field of instructional design, they would have combined their knowledge of the school environment, their teaching experience in the school, and familiarity with the teachers with an analytical, systematic, and evaluative approach in their efforts to help teachers both: (1) integrate technology, and (2) learn the required technology skills necessary to do so. Since the goals of the TRTs were derived from the state's predefined and mandated competency test, the TRTs' approach was reactive rather than proactive. A more proactive, systemic, as well as systematic approach could have resulted in more integration of computers into curriculum. The lack of a formal statement of needs that is based on the analysis of the problem in each school and formal measures did not allow TRTs to monitor or assess the achievement or appropriateness of their goals and strategies, nor did it provide them with opportunity to revise their plan of action .

Implications

If public schools would like to use the time and the money efficiently, they need to use professionals who have not only the characteristics of the TRTs but also skills in instructional design. The study has also implications for instructional technology field.

First of all, in the field of instructional design/technology, more emphasis needs to be placed on the role of instructional designer in the public schools. The results of this study suggest that public schools may be ready to use instructional design skills that for a long period of time had not been utilized. From the findings of this study, the following suggestions may be pertinent to the field.

1. Recruit Educators to Become Potential Instructional Designers in the Public Schools

In order for instructional design to be successfully implemented in schools, the field should place more emphasis on public school settings and recruit newcomers to the field directly from the pool of educators from the school system. The answer may not lie in simply sending newly trained instructional designers into the schools, particularly since this study indicates the importance being familiar with the school system, the school context, and the characteristics of teachers and teaching practices.

2. Include a Public School Internship Component to Instructional Technology Programs

Another way that the instructional design field can aim their efforts towards helping public schools is to include a public school internship requirement in current programs. The majority of graduate programs in instructional design/technology usually require students to complete an internship in business, industry, government, or military settings. Potential applicants interested in public school settings should be required to complete their internship in a public school or schools.

3. Provide Inservice Instructional Technology Training for Public School Teachers

Given that there is an overwhelming demand for public school educators and their students to have computer skills, the instructional technology field can take the leadership and responsibility for providing that training. One of the problems that has kept instructional designers from public education has been the lack of funding to pay for such expertise. Schools and the instructional design field should become partners in their attempts to obtain grants and funding means to support such training efforts.

4. Target Potential Employment Opportunities Such as Technology Coordinator, Technology Resource Teacher, and Other Public School Technology Positions

The results of this study combined with current trends in education suggest that the public school community is ready to use professionals from the field of instructional design. While the schools in this study have such positions in place, other schools in the state and across the nation will be working to solve technology integration problems that will probably result in similar job positions. The field of instructional design may have a rich opportunity at last to affect public schools.

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Appendix A (continued)

Computer Survey

Instructions: Mark all responses on your bubble sheet using a #2 pencil only. The bubble sheets are anonymous and do not require your name, birthdate, identification number or grade or education. However, we would appreciate it if you would please indicate whether you are male or female in the appropriate area on the bubble sheet. Please do not make marks on this questionnaire.

Answer each question as it applies to you at *this* point in your learning and teaching experiences. Your answers will not be shared with anyone and will be kept anonymous.

1. What grade levels do you teach?

   a. 6th grade
   b. 7th grade
   c. 8th grade

2. What subject areas do you teach?

   a Mathematics
   b. Social Studies
   c. Science
   d. Language Arts
   e. Other

3. Are you seeking CEU credit for the computer competency workshops that you take?
   a. Yes
   b. No

4. How many hours of computer workshop training have you completed?

   a. Less than 10 hours
   b. 10-20 hours
   c. 20-30 hours
   d. 30-40 hours

5. Are you currently using computers in your classroom?

   a. Yes
   b. No

6. Before this year, what previous experience have you had in operating computers?
   a. 0
   b. Few days to 1 month
   c. 1-6 months
   d. 7 months to a year
   e. Over a year

7. Describe your home computer:

a. Macintosh
b. IBM Compatible
c. Apple II
d. Other
e. None

8. How would you rate your computer skills before the school year started?

a. Nonexistent
b. Poor
c. Average
d. Good
e. Excellent

9. How would you rate your ability to use a computer now?

a. Nonexistent
b. Poor
c. Average
d. Good
e. Excellent

Answer the next set of items according to how much you **agree** or **disagree** with the statements as follows:

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

10. Knowing how to use computers is a worthwhile and necessary skill.

11. I like using computers.

12. I feel confident about my ability to learn about computers.

13. Working with a computer makes me nervous.

14. I will use my knowledge of computers in many ways as a teacher.

15. Using a computer is more important for males than females.

16. I like using computers in my school work.

17. I wish I could use computers more frequently at the school.

18. I get a sinking feeling when I think of trying to use a computer.

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

19. Once I start to work with the computer, I would find it hard to stop.

20. Computers make me feel stupid.

21. If a problem is left unsolved in a computer workshop or in class, I would continue to think about it afterwards.

22. More men than women have the ability to become computer scientists.

23. Teaching using computers would be very interesting.

24. I don't expect to use computers in my classroom.

25. I look forward to using the computers at school.

26. I'm not the type to do well with computers.

27. I feel comfortable using computers.

28. Working with computers is boring.

29. Using computers is more enjoyable for males than females.

30. When there is a problem with a computer program I can't immediately solve, I would stick with it until I have the answer.

31. Learning about computers is a worthwhile and necessary subject for all teachers.

32. Computers make me feel uncomfortable.

33. It is important to know how to use computers in order to get any teaching position.

34. I know that if I work hard to learn about computers, I can do well.

35. Females can do as well as males in learning about computers.

36. Computers make me feel uneasy and confused.

37. I think working with computers would be both enjoyable and stimulating.

38. I think using a computer would be difficult for me.

39. Working with computers is more for males than females.

40. I am able to do as well working with computers as most of my fellow teachers.

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

41. I will probably need to know how to use a computer in my classroom.

42. Computers are gaining too much control over people's lives.

43. Supplying every student with a computer is a worthy educational objective.

44. Teachers should demand that they be taught how to use a computer in their classrooms.

45. Computers will require learners to become active in their learning.

46. Computer instruction will deny students the opportunity to reason with others.

47. Using computers as a teaching tool puts too much additional work on already overburdened teachers.

48. If we do not use computers in school instruction, our students will grow up illiterate and deprived of a basic skill.

49. If my school district had the money, I would insist that they buy computers in most every school subject.

50. Computers will increase the amount of stress and anxiety teachers experience in schools.

51. Computers will decrease the amount of teacher-pupil interaction in schools.

52. Computers will isolate students from one another.

53. I object to all the attention being given to computer technology because it detracts from the real problems now faced by teachers.

54. Computers can improve learning of higher-order skills.

55. Computers will displace teachers.

56. Computers will dehumanize teaching.

57. Our country would be better off if there were no computers.

58. Someday I will have a computer in my home.

59. Computers will improve education.

Appendix B

Teachers' Attitude Toward Computers--Mean and Standard Deviation Scores.

Liking Computers		M	SD
11.	I like using computers.	1.63	.94
16.	I like using computers in my school work.	1.82	1.02
17.	I wish I could use computers more frequently at the school.	1.82	.94
19.	Once I start to work with the computer, I would find it hard to stop.	2.40	1.14
21.	If a problem is left unsolved in a computer workshop or in class, I would continue to think about it afterwards.	2.41	1.10
23.	Teaching using computers would be very interesting.	2.09	1.07
25.	I look forward to using the computers at school.	1.90	.97
30.	When there is a problem with a computer program I can't immediately solve, I would stick with it until I have the answer.	2.53	1.11
37.	I think working with computers would be both enjoyable and stimulating.	1.88	.91
58.	Someday I will have a computer in my home.	1.63	.95
28.	Working with computers is boring. (Negative item)	4.25	.91

Value of Computer for Education		M	SD
Positive Items			
14.	I will use my knowledge of computers in many ways as a teacher.	1.88	1.03
31.	Learning about computers is a worthwhile and necessary subject for all teachers.	1.58	.90
33.	It is important to know how to use computers in order to get any teaching position.	2.80	1.16
43.	Supplying every student with a microcomputer is a worthy educational objective.	2.12	1.12
44.	Teachers should demand that they be taught how to use microcomputers in their classrooms.	2.09	.95
45.	Microcomputers will require learners to become active in their learning.	2.02	.96
48.	If we do not use microcomputers in school instruction, our students will grow up illiterate and deprived of a basic skill.	2.60	1.23
49.	If my school district had the money, I would insist that they buy microcomputers in most every school subject.	2.18	1.07
54.	Computers can improve learning of higher-order skills.	1.95	.89
57.	Our country would be better off if there were no computers.	1.95	.89
59.	Computers will improve education.	1.70	.90
Negative Items			
46.	Microcomputer instruction will deny students the opportunity to reason with others.	3.75	1.03
47.	Using microcomputers as a teaching tool puts too much additional work on already overburdened teachers.	3.56	1.16
50.	Microcomputers will increase the amount of stress and anxiety teachers experience in schools.	3.51	1.10
51.	Microcomputers will decrease the amount of teacher-pupil interaction in schools.	3.71	1.05
52.	Microcomputers will isolate students from one another.	3.82	.91
53.	I object to all the attention being given to computer technology because it detracts from the real problems now faced by teachers.	3.60	1.17

55.	Computers will displace teachers.	4.14	.96
56.	Computers will dehumanize teaching.	3.96	1.00

Value of Computer for Society		M	SD
Positive Items			
10.	Knowing how to use computers is a worthwhile and necessary skill.	1.29	.71
41.	I will probably need to know how to use a computer in my classroom.	1.63	.93
Negative Items			
24.	I don't expect to use computers in my classroom. (Negative)	4.37	.91
42.	Computers are gaining too much control over people's lives. (Negative)	3.41	1.20

Confidence about Learning Computers		M	SD
12.	I feel confident about my ability to learn about computers.	1.78	.96
34.	I know that if I work hard to learn about computers, I can do well.	1.60	.71

Confidence About Using Computers		M	SD
27.	I feel comfortable using computers.	2.11	1.14
40.	I am able to do as well working with computers as most of my fellow teachers.	1.98	1.02

Anxiety (or Lack of it) about Computers		M	SD
Negative Items			
13.	Working with a computer would make me nervous.	3.52	1.31
18.	I get a sinking feeling when I think of trying to use a computer.	4.06	1.15
20.	Computers make me feel stupid.	4.04	1.15
26.	I'm not the type to do well with computers.	4.13	1.00
32.	Computers make me feel uncomfortable.	3.93	1.16
36.	Computers make me feel uneasy and confused.	3.97	1.11
38.	I think using a computer would be difficult for me.	4.09	1.04

Perception about Gender-Appropriate of Computer Use		M	SD
15.	Using a computer is more important for males than females.	4.58	.92
22.	More men than women have the ability to become computer scientists.	4.61	.73
29.	Using computers is more enjoyable for males than females.	4.54	.83
35.	Females can do as well as males in learning about computers.	1.47	.93
39.	Working with computers is more for males than females.	4.60	.72

Note: For positively-worded statments 1=strongly agree and for negatively-worded statements 5=strongly disagree.

Table 1
Cross tabulation of computer competency exams taken by teachers by school.

Schools

Question	1 (n=17)	2 (n=17)	3 (n=17)	4 (n=17)	5 (n=17)	6 (n=17)
How many hours of computer workshops have completed?	16.0	17.0	16.0	17.0	17.0	17.0
Which of the following computer competency exams have you taken?						
• Keyboarding	14.3	25.7	8.6	11.4	11.4	28.6
• Operating	19.2	34.6	4.5	13.6	9.1	13.6
• Word-processing	22.7	36.4	4.5	13.6	9.1	13.6
• Spreadsheet	23.1	30.8	3.8	7.7	11.5	23.1
• Data base	23.8	42.9	0.0	4.8	9.0	19.0

Table 2
Means and standard deviations of teachers' different computer skills by school.

Schools

Question	1 (n=17) M (SD)	2 (n=17) M (SD)	3 (n=17) M (SD)	4 (n=17) M (SD)	5 (n=17) M (SD)	6 (n=17) M (SD)
List the following computers skills in order of your strongest areas to your weakest area (1= strongest and 9= weakest)						
• Terms and operations	**2.7**	**4.0**	**3.0**	**3.4**	**3.8**	**4.6**
	(1.9)	(2.3)	(2.0)	(1.6)	(2.3)	(2.6)
• Keyboarding	**3.6**	**2.2**	**2.3**	**1.7**	**4.3**	**2.7**
	(2.7)	(2.0)	(2.1)	(1.2)	(2.6)	(2.5)
• Societal uses	**5.8**	**5.5**	**5.5**	**6.4**	**6.4**	**4.3**
	(1.9)	(2.5)	(2.6)	(1.7)	(2.0)	(2.1)
• Ethics	**5.6**	**5.5**	**5.2**	**5.7**	**6.4**	**3.6**
	(2.4)	(2.7)	(2.3)	(2.5)	(2.5)	(2.3)
• Word-processing	**3.8**	**2.7**	**1.7**	**2.0**	**3.1**	**3.6**
	(2.4)	(2.2)	(1.0)	(0.9)	(2.5)	(2.3)
• Data bases	**6.0**	**5.2**	**4.5**	**6.0**	**5.6**	**6.0**
	(2.0)	(1.8)	(1.8)	(1.9)	(2.2)	(1.6)
• Spreadsheets	**5.6**	**5.2**	**4.6**	**5.0**	**5.2**	**6.1**
	(2.1)	(1.8)	(2.7)	(2.3)	(2.4)	(1.6)
• Curriculum software use	**5.6**	**5.7**	**5.0**	**5.7**	**4.6**	**5.1**
	(2.2)	(2.2)	(2.3)	(1.8)	(1.8)	(2.5)
• Telecomputing	**8.0**	**8.2**	**7.7**	**8.2**	**6.8**	**8.3**
	(2.7)	(0.8)	(2.4)	(1.3)	(2.6)	(1.2)

Table 3
Cross tabulation of previous experiences in computer by school.

Questions	Schools 1 (n=17)	 2 (n=17)	 3 (n=17)	 4 (n=17)	 5 (n=17)	 6 (n=17)
Have you had any previous computer course/workshop prior to the school-based computer training program?	14.1	20.3	17.2	12.5	15.6	20.3
Describe your computer skills prior to your training this school year. 17.0 %• I feel I had all 58.0 %• I feel I had some 25.0 %• I feel I had none	17.0 (4) (10) (3)	16.0 (1) (8) (7)	17.0 (3) (10) (3)	17.0 (3) (9) (5)	17.0 (6) (6) (5)	17.0 (0) (15) (2)
Please describe your computer skills at the present time. 27.0%• Confidence in all 49.0%• Confidence in some 24.0%• Need additional	17.0 (4) (8) (5)	17.0 (6) (8) (3)	15.0 (4) (9) (2)	17.0 (3) (11) (3)	17.0 (7) (3) (7)	17.0 (3) (10) (4)

Table 4
Summary of Teachers' Perception of the Role and Responsibilities of Resource Teachers and Summary of Resource Teacher's Perception of his/her Role and Responsibilities.

School	Teachers' Perception of Resource Teacher	%	Resource Teacher's Perception of his/her Role
School 1	• Always there to help and suggest/Advise/Assist teachers/students • Conducts workshops/Provides training sessions • Staff developer • Teaches specific lessons • Direct group instruction/Coordinates activities/Newsletters • Problem-fixer/Trouble shooter with computers • Mentor/Facilitator • Answers questions concerning computer programs • Willing to help in any area	52 16.6 13.0 8.7 8.7 8.7 4.3 4.3 4.3	• Teach teachers to plan lessons for teaching computer competency test • Help teachers to come up with new ideas to use technology in their curriculum • Help teachers in computer lab • Maintain computer lab operation • Troubleshooting

Table 4. (continued)

School	Teachers' Perception of Resource Teacher	%	Resource Teacher's Perception of his/her Role
School 2	• Assist or aids teachers in the use and teaching of computers/ teaches computing skills	30.8	• Train teacher for computer competency test • Prepare students for computer competency tests • Install New Software • Troubleshoot • Keep track of hardware and software
	• Creates certificates/helpful for competency exam	7.7	
	• Helps/Assists with technology lessons	7.7	
	• Facilitate instruction/Technology facilitator	7.7	
	• Aids in teacher performance	3.8	
	• Provides workshops	3.8	
	• Keeps hardware running, installs and orders software	3.8	
	• Manages computer lab	3.8	
School 3	• Troubleshooter/Fixer	27.8	• Provide technical support • Train students for taking computer competency test
	• Helps teacher/students with computer skills and competency test	22.2	
	• Facilitator	11.1	
	• Tutor/Trainer	11.1	
	• Provides support to teachers/Answers questions	11.1	
	• Gives lessons to kids and teachers	11.1	
	• The one and only genius		
	• Runs computer lab	5.6	
	• Seems quite knowledgeable in most aspects	5.6 5.6	
	• Discusses and teaches NC computer competency objectives	5.6	

Table 4 (continued)

School	Teachers' Perception of Resource Teacher	%	Resource Teacher's Perception of her/his Role
School 4	• Teaches computer skills to both staff and students/Helps teacher and students become computer literate	32.3	• Help teachers plan lessons to integrate computer • Help and teach computer skills to students for computer competency test • Maintain computer lab operation • Train teachers for taking computer competency test • Provide workshop
	• Helper/Never too busy to help/Most helpful to all/God's Send to us/Invaluable/Essential	29.0	
	• Technical advisor/trouble shooter	12.9	
	• Computer specialist/Responds to all of our computer needs	9.7	
	• Resource for software/Helps us find software	9.7	
	• Life saver/Our savior	6.5	
	• Offers suggestions/Provides support	6.5	
	• Facilitator	6.5	
	• Helpful with training	6.5	
	• Assists teachers in planning for computer lab	3.2	
	• Guides classroom instruction	3.2	
School 5	• Assist with student instruction/Teaches computer language to students/Design lesson for students	18.8	• Basically troubleshooting in classrooms • I want to be a friendly person that teachers feel comfortable coming to • I don't want to be perceived as a nuts and bolts hardware person
	• Facilitator for computers and computer instruction	18.8	
	• Work with teachers and students on computer skills/usage	14.6	
	• Great resource to help and support	12.5	
	• Trainer/Provide training for teachers/ Provide workshop	10.4	
	• Troubleshooter/Technician	8.3	
	• An expert to consult with	8.3	
	• Help students and teachers with any questions/new information	8.3	
	• Assist teachers in finding materials for use with classes	6.3	

Table 4 (continued)

School	Teachers' Perception of Resource Teacher	%	Resource Teacher's Perception of her/his Role
School 6	• Provides computer workshops/Trains teachers and provides enrichment/Trains teachers in technology	36.6	• Show teachers what technologies we have and how they can utilize them • Convince teachers that they save time by using computers • Lots of troubleshooting • Make teachers feel comfortable with computers and with their computer skills • Make teachers comfortable to bring their students to computer lab
	• Teacher of teachers/Assistant to teachers and students	27	
	• Troubleshooter/keeps computers in working order	23	
	• Facilitator/Rescuer	16.6	
	• Helps plan and implement computer lab lessons/Consultant for class activities/Teaching or introducing new skills to students	16.6	
	• Helps teach lessons/Helps teach classes and answer questions	16.6	
	• Install and maintain computer programs/software	6.7	
	• Too vast to mention/Is other half of my brain	6.6	
	• Keeps us abreast of technology		
	• Assist with technical problems	6.6	
	• Is omniscient in computer lab	6.6	
	• Aids in the use of computer for instruction	3.3 3.3	

Table 5

Summary of teachers' responses to the question "In what ways TRT help you with computer usage?."

Categories of Responses	School # 1	School # 2	School # 3	School # 4	School # 5	School # 6	Average
1. Finding proper software/ updating software.	34.8% (8)	11.1% (3)	16.7% (3)	3.2% (1)	16.7% (8)	13.3% (4)	16.0%
2. Available all the time to help with what we want.	26.1 (6)	7.4% (2)	16.7% (3)	16.1% (5)	4.2% (2)	26.7% (8)	16.2%
3. Teaching how to use computer/teaching computer competency test.	13.0% (3)	11.1% (3)	16.7% (3)	19.4% (6)	4.2% (2)	26.7% (8)	15.2%
4. Helping through staff development and workshops.	17.4% (4)	18.5% (5)	16.7% (3)	6.5% (2)	10.4% (5)	16.7% (5)	14.4%
5. Trouble shooting	13.0% (3)	0.0% (0)	22.2% (4)	16.1 (5)	8.3% (4)	16.7% (5)	12.7%
6. Answering question about technology.	26.1% (6)	7.4% (2)	0.0% (0)	12.9% (4)	4.2% (2)	16.7% (5)	11.2%
Total number of observations	**23**	**27**	**18**	**31**	**48**	**30**	

Table 6
Resource Teachers' versus Teachers' Perceptions of TRT Role

Job Description Role and Responsibility	Technology Coordinators' Perception	Principals' Perception
Instructional 8 phases Technical 4 phases Administrative 5 phases **Instructional** •teach introductory and computer related lesson •assist teachers in selecting and using materials and equipment suitable for grade level •update computer curriculum •assist teachers in integrating computer activities •assist teachers in implementing special projects with multimedia, publications, telecommmunications •teaching demonstration lessons with more software •assist teachers with understanding of computers •responsible for helping teachers pass competency test **Technical** •supply technical expertise •troubleshooting computers, printers, etc, •serve as consultant for purchasing equipment •install new equipment **Administrative** •distribute copies of items and state licenses •distribute documentation of district owned and licenses software •maintain a schedule for computer lab •work with media specialist to keep inventory •work with technology department as a member **Qualifications** •knowlege in the application of instructional technology •experience in working with teachers •at least three years teaching experience	•we looked at technical skills and hardware and software knowledge •we really concentrated a lot on skills of working with DOS, to do training with DOS which would be intimidating to adults •we did not focus on years of teaching (3 years teachings is one of the job qualifications for the position) •we just want somebody who has solid background with good skills in technology •they need to be very personable and be able to work with people •they should have had some experience in training adults	•I would want somebody very comfortable in technology •Technical knowledge •Someone who can interface with people and has good people skills •Human rapport and understanding of teachers •Someone in-house on faculty so transition would be easier •Warm and nuturing personality, not intimidating •Committed to staff and students •A teacher and facilitator

Table 7
Summary of teachers' responses to the question "Describe how you use the computer in your classroom to aid students learning within the subject area you teach."

Categories of Responses	School # 1	School # 2	School # 3	School # 4	School # 5	School # 6	Average
1. Use subject matter related software	21.7% (5)	3.7% (1)	22.2% (4)	22.6% (7)	27.1% (13)	26.7% (8)	21.0%
2. Use word-processing software	34.8% (8)	14.8% (4)	22.2% (4)	29.0% (9)	10.4% (5)	10.0% (3)	20.2%
3. Use for remediation, enrichment	43.5% (10)	3.7% (1)	11.1% (2)	16.1% (5)	10.4% (5)	13.3% (4)	16.4%
4. Use for keyboarding	13.0% (3)	7.4% (2)	0.0% (0)	3.2% (1)	0.0% (0)	6.7% (2)	5.1%
5. Use for lesson planning/tests/ transparencies	0.0% (0)	3.7% (1)	5.6% (1)	6.5% (2)	6.3% (3)	6.7% (2)	4.8%
6. use games for reinforcement/ motivation.	4.4% (1)	7.4% (2)	0.0% (0)	3.2 (1)	2.1% (1)	6.7% (2)	4.0%
Total number of observations	**23**	**27**	**18**	**31**	**48**	**30**	

Table 8
Cross tabulation of classroom computer and its usage by school.

School

Questions	**1** (n=17)	**2** (n=17)	**3** (n=17)	**4** (n=17)	**5** (n=17)	**6** (n=17)
Do you have computer in your classroom?	17.4 (15)	16.3 (14)	15.1 (13)	19.8 (17)	15.1 (13)	16.3 (14)
Is your classroom computer compatible with the other computers in your school and with the computer lab?	18.8	16.3	15.0	20.0	15.0	15.0
Do you have any software in your classroom?	16.9	18.3	18.3	15.5	14.1	16.9
Which of the following describes how you are using your classroom computer and educational software?						
• Design visual presentation	8.3	8.3	12.5	16.7	25.0	29.2
• Prepare hand-outs & print	15.1	18.9	17.0	17.0	15.1	17.0
• For remediation	28.1	15.6	18.8	6.3	18.8	12.5
• Enhance learning	20.0	14.0	18.0	16.0	16.0	16.0

Table 9
Teachers' responses to the question "Why have you selected certain areas as your weakest areas?."

Categories of Responses	School # 1	School # 2	School # 3	School # 4	School # 5	School # 6	Average
1. Lack of experience.	30.4% (7)	33.3% (9)	27.8% (5)	3.2% (1)	45.8% (22)	56.7% (17)	32.9%
2. Need more instruction.	43.5% (10)	3.7% (1)	27.8% (5)	3.2% (1)	31.3% (15)	16.7% (5)	21.0%
3. Lack of facilities.	0.0% (0)	0.0% (0)	3.7% (1)	0.0% (0)	0.0% (0)	0.0% (0)	3.7%
Total number of observations	**23**	**27**	**18**	**31**	**48**	**30**	

Table 10
Results of background questions in the Computer Attitude Survey before equalizing the sample size across schools.

Questions			**Responses**		
1. What grade level do you teach?	6th (43) 21%	7th (46) 22%	8th (45) 21%	Others (62) 35%	
2. What subject areas do you teach?	Math (26) 12.6%	Science (19) 9.2%	LA (38) 18.4%	Social Studies (14) 6.8%	Other (109) 52
3. Are you seeking credit for computer competency workshop that you take?	Yes (160) 77.7%	No (39) 18.9%			
4. How many hours of computer workshop training have you completed?	>10 (45) 21.8%	10-20 (74) 35.9%	20-30 (36) 17.5%	30-40 (50) 24.3%	
5. Are you currently using computers in your classroom?	Yes (168) 81.6%	No (37) 18%			
6. Before this year, what previous experience have you had in operating computers?	0 (23) 11.2%	Few days to 1 M (32) 15.5%	1-6 M (17) 8.3%	7 M to1 Y (16) 7.8%	Over 1 Y (118) 57.3%
7. Describe your home computer.	Mac (10) 4.9%	IBM (92) 44.7%	Apple (5) 2.4%	other (18) 8.7%	None (75) 36.4%
8. How would you rate your computer skills before the school year started?	None (19) 9.2%	Poor (63) 30.7%	Average (69) 33.5%	Good (42) 20.4%	Excellent (13) 6.3%
9. How would you rate your ability to use computer now?	None (5) 2.4%	Poor (35) 17.0%	Average (78) 37.9%	Good (64) 31.1%	Excellent (24) 11.7%

Table 11
Correlation between liking computers and other variables

Variables	N	R
Liking computers vs. value for computers	133	.2851*
Liking computers vs. confidence for learning computers	134	.6542*
Liking computers vs. confidence for using computers	134	.6569*
Liking computers vs. value for computers in education	133	.2851*
Liking computers vs. rate computer skills before this year	135	.4760*
Liking computers vs. rate using computers now	135	.5024*
Liking computers vs. previous experience with operating	135	.3725*
Liking computers vs. current usage of computer in class	135	.2482*

*P<.001

Table 12
Correlation between confidence for learning computers and the other variables

Variables	N	R
Confidence for learning computers vs. value for using computers	141	.6534*
Confidence for using computers vs. confidence for learning computers	141	.6534*
Confidence for learning computers vs. rate computer skills before this year	142	.3823*
Confidence for learning computers and rate ability using computers now	142	.5056*
Confidence for learning computers vs. previous experience with computers	204	.2652*

*p<.005

Table 13
Correlation between value for computers in education and other variables

Variables	N	R
Confidence for using computers vs. previous experience with computers	142	.5050*
Confidence for using computers vs. rate computer skills before this year	142	.6320*
Confidence for using computers vs. rate ability using computers now	142	.6400*
Confidence using computers vs. hours of computer competency workshop	141	.3001*

*p<.001

Table 14
Correlation between anxiety for computer and the other variables

Variables	N	R
Anxiety for computer vs. liking computers	134	.5486*
Anxiety for computers vs. confidence for learning computers	141	.5928*
Anxiety for computers vs. confidence for using computers	142	.7685*
Anxiety for computers vs. rate computer skills before this year	142	.5758*
Anxiety for computer vs. rate ability to use computers now	142	.5486*

*p<.001

Table 15
Correlation between rate of computer skills and other variables

Variables	N	R
Rate of computer skills vs. hours of computer competency workshops	143	.2642*
Rate computer skills before this years vs. rate ability to use computers now	144	.7269*
Rate ability to use computer vs. hours of computer competency workshops	143	.3229*

*p<.001

Table 16:
Correlation among variables in general survey.

Variables	R	P value
Home computer vs. computer skills at present	.3007	.01
Home computer vs. computer skills prior to training	.2630	.01
Home computer vs. home computer usage	.5372	.01
Home computer usage vs. computer skills prior to training	.2543	.05
Home computer usage vs. computer skills at present	.2605	.05
Computer skills prior to training vs. computer skills at present	.6856	.01
Computer skills at present vs. hours of computer workshop	.3930	.001

Table 17
Descriptive statistics for teachers' attitude toward computer by six different schools

	School 1 (n=24)	School 2 (n=24)	School 3 (n=24)	School 4 (n=24)	School 5 (n=24)	School 6 (n=24)
Factors measured teachers' attitude toward computers	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
1. Liking computers	**24.2**	**25.6**	**22.9**	**25.6**	**21.1**	**24.2**
	(4.8)	(4.9)	(5.7)	(8.2)	(6.5)	(6.7)
2. Value for computer in education	**49.5**	**49.5**	**50.0**	**50.7**	**48.8**	**48.4**
	(4.6)	(3.6)	(2.8)	(4.0)	(6.5)	(8.7)
3. Confidence for learning computers	**3.6**	**3.3**	**3.1**	**3.6**	**2.7**	**3.1**
	(1.0)	(1.2)	(1.2)	(1.7)	(1.1)	(1.1)
4. Confidence for using	**4.1**	**3.8**	**3.4**	**4.4**	**3.8**	**4.1**
	(1.4)	(1.7)	(1.3)	(2.1)	(2.5)	(2.1)
5. Anxiety for computers	**28.1 28.5**	**30.8**	**26.5**	**27.3**	**27.6**	
	(4.8)	(5.3)	(4.3)	(7.4)	(7.3)	(7.7)

Table 18
Descriptive statistics for teachers' attitude toward computer by those who are currently suing computers and those who are not currently using computers.

	Using computers		Not Using computers	
Factors measured teachers' attitude toward computers	M	SD	M	SD
1. Liking computers	23.2	5.8	28.1	7.9
2. Value for computer in education	49.1	5.4	52.6	4.6
3. Confidence for learning computers	3.2	1.2	3.5	1.6
4. Confidence for using computers	3.8	1.8	4.5	2.1
5. Anxiety for computers	28.4	6.1	26.6	7.5

Table 19
Descriptive statistics for teachers' attitude toward computer by previous experience in operating computers.

Factors measured teachers' attitude toward computers	0 experience M (SD)	Few days M (SD)	1 to 6 months M (SD)	7 month M (SD)	Over a year M (SD)
1. Liking computers	**21.9**	**23.2**	**24.8**	**27.2**	**30.7**
	(6.4)	(7.6)	(4.7)	(4.0)	(5.3)
2. Value for computer in	**103.0**	**102.7**	**104.8**	**104.7**	**105.5**
education	(6.2)	(4.1)	(3.0)	(3.8)	(6.9)
3. Confidence for learning	**2.9**	**3.5**	**3.3**	**3.7**	**3.9**
computers	(1.0)	(1.3)	(1.5)	(1.7)	(1.1)
4. Confidence for using	**3.3**	**3.9**	**4.0**	**0.0**	**0.0**
computers	(1.5)	(1.3)	(1.2)	(0.0)	(0.0)
5. Anxiety for computers	**20.8**	**28.2**	**28.8**	**25.9**	**20.7**
	(5.8)	(3.4)	(3.6)	(6.1)	(7.0)

Descriptive statistics for teachers' attitude toward computer by rate computer skills before school year.

Factors measured teachers' attitude toward computers	**None** M (SD)	**Poor** M (SD)	**Average** M (SD)	**Good** M (SD)	**Excellent** M (SD)
1. Liking computers	**19.1**	**19.1**	**24.1**	**26.7**	**30.2**
	(5.3)	(3.9)	(5.8)	(5.8)	(5.8)
2. Value for computer in	**104.2**	**102.2**	**103.4**	**104.1**	**106.2**
education	(2.8)	(6.0)	(6.7)	(3.6)	(6.8)
3. Confidence for learning	**2.3**	**2.6**	**3.3**	**3.8**	**3.8**
computers	(1.0)	(0.7)	(1.1)	(1.4)	(1.3)
4. Confidence for using	**2.0**	**2.7**	**3.7**	**5.1**	**6.1**
computers	(0.0)	(1.2)	(1.2)	(1.8)	(2.3)
5. Anxiety for computers	**34.4**	**31.3**	**29.2**	**24.9**	**20.7**
	(1.3)	(5.1)	(4.7)	(5.8)	(7.4)

Table 21: Descriptive statistics for teachers' attitude toward computer by rate ability to use computer now.

Factors measured teachers' attitude toward computers	**None** M (SD)	**Poor** M (SD)	**Average** M (SD)	**Good** M (SD)	**Excellent** M (SD)
1. Liking computers	**17.9**	**21.6**	**25.7**	**30.3**	**22.0**
	(3.2)	(4.6)	(5.7)	(6.2)	(2.8)
2. Value for computer in	**102.0**	**103.5**	**104.0**	**104.7**	**101.5**
education	(6.6)	(4.3)	(6.5)	(5.2)	(3.5)
3. Confidence for learning	**2.1**	**2.7**	**3.6**	**4.5**	**2.0**
computers	(0.3)	(0.8)	(1.0)	(1.5)	(0.0)
4. Confidence for using	**2.2**	**3.0**	**4.3**	**6.6**	**2.5**
computers	(0.6)	(1.1)	(1.3)	(1.8)	(0.7)
5. Anxiety for computers	**32.7**	**30.8**	**27.0**	**19.8**	**34.5**
	(4.9)	(4.3)	(4.5)	(6.5)	(0.7)

Table 22

Multivariate analysis of variance for teacher's attitude toward computers school, usage of computer, previous experience and rate of computer skills.

Multivariate Tests of Significance		**Univariate F Ratio** Factors measuring teachers' attitude toward computers				
Source	F	1	2	3	4	5
1. Attitude by school	0.78	1.6	0.52	1.59	0.70	1.24
2. Attitude by usage of computer	0.88*	10.45*	7.93**	0.733	2.27	1.39
3. Attitude by previous computer experience	0.62***	9.4***	0.62	2.9	12.1**	8.3***
4. Attitude by rate computer skills before school year	0.51***	12.6***	1.0	6.5***	19.9***	15.6***
5. Attitude by rate ability to use computer now	0.40***	17.0***	0.69	16.6***	35.3***	22.3***

Note: Analyses are on (1) liking computers, (2) value for computer in education, (3) confidence learning computers, (4) confidence using computer, and (5) anxiety for computers.

1 df= 5, 124 2 df= 1, 1283 df= 1, 125 4 df= 4, 125

* p<.05 **p<01 ***p<.001

Title:

Responding to Cultural Diversity

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This paper reflects the contributions of five professors and one doctoral student of Educational Technology, who serve as panelists for the 13th Annual Foundations Symposium and Open Forum. This year's theme is *Responding to Cultural Diversity*, and continues the tradition of presenting topics and issues that are of current relevance to the field, and are foundational in nature. The issue at hand — the impact of learner diversity on the practice of Educational Technology — is one which extends the current boundaries of the field and fosters dialog between and among the presenters and audience.

Both this manuscript and open forum extend the present knowledge base in the field by addressing key critical issues regarding learner diversity. The body of this document is presented in six parts: 1) Powell begins by asking why address diversity, why should the field listen, what the benefits are, and for whom; 2) DeVaney questions why culture has not been a part of the Educational Technology discourse; 3) Branch examines mechanisms for utilizing existing frameworks for incorporating cultural pluralism into instruction; 4) Knupfer reveals the impact gender has on the design of instruction; 5) Thompson asserts that cultural diversity must be explicitly addressed within current ID models; and 6) Reeves reflects on personal experiences evaluating culturally insensitive materials.

(1) Responding to Cultural Diversity: Who, Why, and For What?

Gary C. Powell, Ed.D.

Why address diversity? The rhetoric of educational technology (as depicted in design models and development guides) is very clear that learner characteristics such as prior knowledge, entry behaviors, ability and motivation must be taken into consideration to increase student learning. Teachers and designers both are urged to recognize those psychological characteristics that set one student off from another. Instruction is more effective when it is fitted to a learner's uniqueness as a person. Such matters as mental abilities, aptitudes, and motivations are thus regarded as individual endowments worthy of respect and available for use in the learning process. Matters of cultural, racial and ethnic diversity, however, have not elicited similar treatments in the educational technology literature, including our texts, journals, and conference presentations. No longer can instructional technology ignore the critical challenges to educating diverse students. Preparing learners to function in an ever-changing international marketplace requires paradigmatic shifts in the art and science of educational technology.

Why should I listen? There is strong support, particularly from researchers and practitioners in other fields of Education, that learners' perceptions of the educational process depends largely on the values, attitudes, and behaviors of those within their cultural group. All learners therefore bring culturally based rules, expectations, value systems, and needs about education to the learning environment. Increasing our ability to understand them, respond to them, and accommodate for them within the current Instructional Systems Design framework, takes us one step closer to education which is meaningful, relevant and effective for all. 'All' includes persons who may not look or sound like us, and who's preferred learning and teaching styles may not be the same as ours either. It is critical that we as educators value these alternative styles, and see them as viable and valid assets to instruction. We should not imposing practices, orientations or expectations which reflect our own (often mainstream) culture on others.

How shall I benefit by responding to diversity? Good question! Perhaps a better question should be how shall my *learning audience* benefit, because your benefit (what's in it for me) will stem from that of the learners. In other words, as designers, we experience satisfaction when we accurately and consistently meet the psychological and motivational needs of the populations for whom we design instruction. We faithfully follow our models, and focus on individual characteristics (entry behaviors) such as motivation, age, achievement level, cognitive style and reading level. The end result (at times) is 'effective' instruction; at which point we are happy. While important to address, such traditional individual characteristics miss other salient forms of diversity, especially cultural. The cultural background of the learner must be determined and explicitly addressed. Basic learner analysis and user-centered designs are not enough, because like it or not, designers' instructional 'creations' are shaped by their own culturally influenced values, norms, beliefs and morals.

How will you benefit by responding to diversity? First, by recognizing that you now have adequately analyzed your learning audience (which in all contexts grows more diverse each day). And second, from the satisfaction of successfully incorporating a culturally pluralistic focus into the design of instruction, such that it capitalizes on learners' distinctive learning styles, strengths and orientations.

Who am I?! You are an instructional technologist, instructional designer, needs assessment expert, evaluation expert, media specialist, curriculum specialist, teacher, administrator, professor, HRD expert, training manager or trainer who wishes to deliver instruction which is responsive to the needs of diverse learners.

(2) Negligent Discourse

Ann DeVaney, Ph.D.

As the field of educational technology emerged from the audiovisual area, scholars and practitioners yearned for a neutral discourse that would bring rigor and respect to the field. Informed by behavioral theory and systems models, a dominant discourse did coalesce (DeVaney and Butler, 1996). It claimed to be culture free and no communications about race and gender appeared for decades. Can these conversations now take place?

A discourse is an informal system of thought that is apparent in the rhetoric of scholarship, speech and pedagogy within a discipline. You can't pin it down and dissect it, but it is there and its material effects are felt (Bove, 1992). Some people believe that the Oklahoma City bombing was the material effect of the rhetoric of a specific discourse. The morning after the Iowa caucuses, Bob Dole adopted the rhetoric of a specific form of populism that had garnered many votes for Pat Buchanan. The material effects of a discourse that excludes talk about race may be fewer jobs for people of color in the field that espouses the discourse.

Although many discourses inform scholarship in educational technology, there has always been a dominant one, a sanctioned discourse that forms official knowledge in the field. (Apple, 82) Whether it was audiovisual research in the 20s, 30s, or 40s; or instructional technology in the 50s, or 60s; or instructional systems technology in the 70s and 80s, a hallmark of the official knowledge was its valorization of psychology, the study of the brain, a unit of one. Whether connectionism, operant conditioning, information processing or schema theory, educational technology scholars used models of brain functions to describe the relationship between machines and learning, or software design and learning. The field appeared inextricably linked to the field of educational psychology, so much so that it was hard for practitioners to conceive of learning in terms more expansive then the explanation offered by a unit of one. (DeVaney and Butler, 1996) From Immanuel Kant to the philosophers of the Vienna Circle, the concept of the mind and brain has been boxed and delivered to educators in the rhetoric of mathematics and physics (Rundell, 1996).

Not to belabor the point, but we have suffered under the tyranny of psychology. The discourse used to describe human learning was devoid of concepts of culture, yet we all recognize that we only learn some things because of our membership in a group. We recognize that meanings are negotiated. The frequent iteration of certain concepts, theories, definitions, assumptions and values has created a psychological discourse that shackled our thinking about learning; that shackled our epistemologies.

Some postmodern discourses break the shackles of reductive psychological notions (Derrida, 70, 76, 78; Foucault, 79; Rorty, 82, 91). Yet of all the 80s and 90s scholarship in schools of education, why is ours the last to consider issues of culture, issues of race, gender and ethnicity. Rather than answer that question directly, I'd like to say that the time is here for discussion of educational technology and cultural pluralism. And, I'd like to ask you to listen and try to identify what discourses inform the messages of our speakers today on cultural pluralism.

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(3) Utilizing Existing Frameworks for Incorporating Cultural Pluralism into Instruction

Robert Maribe Branch, Ed.D.

Instructional technologists have tools available to respond to the current demand for planning instruction which is culturally sensitive. The domains of instructional technology (Seels & Richey, 1994) offer a conceptual framework for understanding the relationship between research, theory and practice of inclusive educational communications. Systematic designs of instruction (Andrews & Goodson, 1980; Edmonds, Branch & Mukherjee, 1994) provide procedural frameworks for identifying opportunities to assure an appropriate match between abilities, values and perceptions of the intended learner audience, and negotiated learner outcomes. The common events associated with an instructional episode (Gagné, Briggs & Wager, 1992) suggests a pedagogical framework for accomplishing exchanges where learners deconstruct and construct knowledge through cultural perspective. The purpose here is to recommend ways in which instructional designers can routinely incorporate cultural pluralism into episodes of instruction.

Pluralism, rather than diversity, is the term of choice because cultural diversity exists within any learner audience regardless of whether or not the quality or quantity of the diversity is acknowledged by the instructional designer. Cultural pluralism requires action in order to realize any learner potential. Therefore, diversity is merely a recognition state, which is passive; while pluralism is an active state requiring purposeful activities designed to elicit the uniqueness of the individuals that form the group. Thus, diversity of the learner audience emerges as positive attributes upon which an instructional episode can be constructed.

The domains of instructional technology: *design, development, evaluation, management* and *diffusion* (Seels & Richey, 1994), conceive categorical notions about how to research, theorize and practice instruction. Each domain also offers an opportunity to incorporate culture as part of an educational communication. *Design* offers the opportunity to scrutinize the origin of content and other knowledge structures in order to determine the validity and meaningfulness of what is to be taught. *Development* offers opportunities to study the impact inclusive ideas will have on an ability to deliver those ideas. *Evaluation* offers opportunities to explicitly assess the value of instructional content relative to the values of the learner audience. *Management* offers opportunities to insure issues of equity and access are addressed among organizations and institutions associated with education, training and the development of human resources. *Diffusion* of innovations offer opportunities to extend ideas about the value of diversity and pluralism beyond surface levels to deep levels so that incorporating cultural pluralism becomes a way of life. While the domains of instructional technology conceptualize opportunities for culturally pluralistic instruction, the systematic design of instruction provides procedures for realizing the research, theory and practice conceived among the domains.

Instructional design that is systemic, systematic, based on general systems theory, and adopts an input-process-output paradigm provides procedures for incorporating cultural pluralism into instruction. The components of a systems approach model: *determine instructional goal, analyze the instructional goal, analyze learners and contexts, write performance objectives, develop assessment instruments, develop instructional strategy, develop and select instruction, design and conduct the formative evaluation of instruction, revise instruction* and *conduct summative evaluation* (Dick & Carey, 1996), can independently facilitate ways to assure instructional designers that cultural aspects are consistently incorporated into any instruction.

Determine instructional goal provides a procedure where learner expectations can originate from analyses of people already doing a job and are similar in cultural background as members of the learner audience. *Analyze the instructional goal* provides a procedure where a diagram is generated that illustrates the diverse skills and knowledge required for a learner to achieve a goal. *Analyze learners and contexts* provides a procedure where individual learners and grouped learner audiences can be understood in terms of their preferences, skills and attitudes that are culturally influenced. *Write performance objectives* provides a procedure where specific expectations of the learner can be matched directly with the cultural values and learning styles of the learner. *Develop instructional strategy* provides a procedure where each event of an instructional episode can correlate with activities relevant to out-of-school experiences of the learner audience which support knowledge construction and skill acquisition. *Develop and select instruction* provides a procedure where instructional media is utilized to portray images and discourse similar to the learner audience. *Design and conduct the formative evaluation of instruction* provides a procedure where members of the intended audience directly inform the instructional improvement process by adding his or her own perspective about any planned instructional episodes. *Revise instruction* provides a procedure where each person can add data, information, knowledge and wisdom to the planned instruction based on personal cultural perspectives. *Conduct summative evaluation* provides a procedure where the value and worth of any instruction can be subjected to the critical judgment of all stakeholders in terms of cultural sensitivity. While instructional design provides a framework of procedures for incorporating cultural pluralism into instruction, the sequence of events which actually form the instructional episode depend upon a pedagogical framework that supports categorical inclusions of cultural perspectives.

Instructional episodes established to promote action-based, interactive and purposeful exchanges enhance the potential for learning content and culture. The nine events of instruction: *gaining attention, informing learner of the objective, stimulating recall of prerequisite learning, presenting the stimulus material, providing learner guidance, eliciting learner performance, providing informative feedback, assessing performance,* and *enhancing retention and transfer* (Gagné, Briggs & Wager, 1992) have the potential to promote knowledge exchanges from cultural perspectives.

Gaining attention can be accomplished by displaying images or objects a learner is likely to encounter in a normal day; and which relate directly to content of the instructional episode. *Informing learner of the objectives* can be accomplished by avoiding jargon and using language common to the learner audience without degenerating to slang, profanity or colloquialism which may detract from the attainment of new vocabulary. *Stimulating recall of prerequisite learning* can be accomplished by asking learners what is important about the intended outcomes of a planned instructional episode. *Presenting the stimulus material* can be accomplished by asking learners to identify ideas, thoughts and perspectives that are similar and different from their own perspective. *Providing learner guidance* can be accomplished by utilizing examples and artifacts familiar to the learner. *Eliciting learner performance* can be accomplished by encouraging learning within a familiar cultural context or within a cultural context which one desires to become familiar. *Providing informative feedback* can be accomplished by comparing and contrasting learner perceptions of the content with the perceptions of content specialists who share common cultural interest with the learner. *Assessing performance* can be accomplished by encouraging the learner to compare his or her performance with the expected performance, and propose changes that can be compared to teacher recommendations. *Enhancing retention and transfer* can be accomplished by varying the cultural context where a particular knowledge or skill can be demonstrated consistent with measures of success identified in the criteria of the stated objective(s). While the sequence of events which form an instructional episode suggests a pedagogical framework where cultural pluralism can be accomplished, there is no substitute for the personal commitment required to plan and successfully implement cultural pluralism into instruction.

A learner-centered perspective as a philosophical orientation to instructional technology is essential in order to incorporate cultural pluralism into instruction. Further, there are four requisites for promoting cultural pluralism:

- Facilitating learner achievement is the fundamental purpose.
- Teachers of any subject can promote cultural pluralism.
- There are invisible privileges inherent in the classroom.
- Cultural pluralism can be effectively incorporated into instruction when planning to teach.

The main caveat for people sincerely interested in instructional technology frameworks that support cultural pluralism is not to make assumptions about individual values based on group norms. Figure 1 highlights a relation between cultural and individual differences.

Six considerations are recommended prior to attempting to incorporate cultural pluralism into instruction:

- Understand your own perceptions.
- Offer positive perspectives.
- Prepare sufficiently.
- Set rules of respect.
- Begin with non-threatening issues.
- Optimize the teachable moment. (Branch, Goodwin & Gualtieri, 1993)

The development of new conceptual tools and procedures for responding to needs for creating culturally sensitive instruction is important, however, in the meantime, instructional technologists should consider utilizing existing frameworks for incorporating cultural pluralism into instruction.

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(4) Gendered by Design: Reflections on a Social Construct with Deep Historical Roots

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To the casual observer an initial survey of instructional design theory and practice might not reveal any obvious pattern in relation to gender. Instructional designers historically have taken the "one size fits all" approach and until recent years have been called to task on this only mildly. Yet a close examination of instructional design and gender, reveals a clear, consistent, and pervasive relationship that has deep historical roots, and that winds throughout our daily lives and perpetuates itself through its interweavings with society.

These roots continue to support instructional design in its historical sense by constantly feeding the old system while all but strangling attempts to pay serious attention to gender equity (McCormick, 1994; Gornick & Moran, 1972). Materials developed for use in public, private, and military schools as well as instructional messages delivered to the public through advertising, television, and public service messages continue to portray women and men in stereotypical ways. Despite attempts to correct this situation over many years, a recent study of computer clip-art images reveals that the stereotypes have invaded the desktop computing environment, with images of men depicted in leadership and authority roles, while women are depicted in subordinate roles (Binns & Branch, 1995).

The complexities of this relationship are enormous, yet can be difficult to recognize, reveal, analyze, explain, and redirect. Like society itself the complexities reflect the dynamics of different situations in different ways, among different individuals. An examination of the complex relationship between instructional design and gender reveals inequities that result from a persistent pattern of practice. Recognizing the result of those inequities can be easier than finding the causes and correcting the problem at its root. Like a cancer, its result shows up at different stages and in different ways, among different individuals. If left untreated, it devastates the person. But recognizing the disease is much easier than finding a reliable cure.

Inequities that result from the practice of instructional design often go unrecognized because they emerge not just as a result of what has been done, but also as a result of what has been left undone. The neglect and omission of the female population reveal themselves in subtle ways on an individual basis, but as a collective result appear throughout society as something that begins in the home, and perpetuates itself through schooling and employment practices. If that was not the case, then there would be no need for recent efforts to attract girls into the study of math and science (Kable & Meece, 1994) and the number of distressing stories about females succeeding despite the myriad of obstacles (Aisenberg & Harrington, 1988; Clark & Corcoran, 1986; Frenkel, 1990; Gornick, 1990) would no longer be told.

Although many scholars insist that great strides have been made concerning equity, they would be hard pressed to explain why it was necessary and yet took so many years to begin such a conversation among leaders in the field. Yet the first open conversation held at the Annual Meeting of Professors of Instructional Design and Technology concerning the need to attend to equitable treatment of females and people of differing cultural backgrounds was held among the delegates in May, 1995. Even sadder is the fact that at least two of the well-established men who seemed to make sense of and contributed positively to the group conversation, made extremely prejudicial statements following the conversation. This, I can only interpret as either unwillingness or inability to see beyond their current practices, beliefs, and biases. The real concern goes beyond the biases of two leaders, but to the larger dimension of the students they teach, the instructional designers and teachers they train.

The socially constructed meaning, expectations, and opportunities based on gender begin with differing expectations for people, depending upon their sex at birth (Stern & Karraker, 1989). The recent news media attention to the pathetic and heart-wrenching plight of unwanted baby girls who have been killed or dumped in orphanages (Chen, 1996; Human Rights Watch, 1996; Tyler, 1996) is not a value that is restricted to Chinese culture. It is a value the reflects itself in the daily lives and education of many people in many cultures. It reveals itself in the way we groom boys for leadership positions while we teach girls to be submissive, in the way we emphasize the importance of male-dominated sports, in the way teachers respond to boys differently than to girls (Olivares & Rosenthal, 1992), in the way stereotypes are perpetuated in the media (Kilbourne, 1990; Schwartz & Markham, 1985), and in the way we recruit for jobs (Bem & Bem, 1973; Fidell, 1975; Rowe, 1990). It reveals itself in the way we provide examples, exercises, and meaningful educational opportunities that boys can often relate to better than girls. It reveals itself in the grooming of boys for entire categories of jobs involving science, math, medicine, and politics. For example, can you explain how a girl would know that national television advertisements about hotline counseling at "Boystown" possibly could be meant to serve girls as well as boys? Never a mention of this is made. Or perhaps you could explain why there is a dearth of girls applying to attend "Boys State" during special summer sessions at college campuses. Does our society really wish to imply that gender is so very important in shaping future political leaders that the very name of a program must discourage girls from attending?

Girls can achieve equally well in the aforementioned areas but have not been encouraged to do so until recently. And now the attempts are filled with remaining hurtles and barriers that must be overcome (Top, 1991). Meaningful instructional design practice must do more to attend to these matters and take an active role in encouraging girls (Van Nostrand, 1991). While not enough has been done and it is too late for many, instructional designers can begin to make amends for those girls who have yet to come through our nation's school systems and workforce training programs. Instructional designers can make a better effort to provide experiences that girls can relate to, offering instructional opportunities that are not gender biased, and encouraging teachers to actively attend to issues of gender equity (Turkle & Papert 1990).

Instructional designers can influence the entertainment industry, home market, school environment, and practices in business and military environments. Designers can accept the importance of their role in shaping the self concept and encouraging equitable access to job skills that later translate into life skills and wages commensurate with experience. A more positive and forward-thinking outlook on the role of females in our society can certainly do much to influence the drive and effort that is currently necessary for females to overcome the many obstacles in daily life.

Instructional designers can influence educational practice by designing instructional environments that attend to the needs of the female population as well as those of males. They can encourage reflective practice that makes adjustments to the needs at hand. The information age brings the challenge of shifting responsibilities. Even through the majority of network users are males (Shade, 1993), females must be encouraged to learn skills and be provided with opportunities to have equal access to information.

Until society gets beyond viewing women as second class citizens in stereotypical roles, then instructional designers will have a difficult job in educating the public. Yet it can be done. The first step is to educate instructional designers to attend to the needs of a pluralistic society. The second step is to encourage business, industry, government, and education institutions to include knowledgeable designers on their project development teams. The designers can produce text-based and mediated materials that attend to the needs of females as well as males. Further, they can provide better training for teachers and others who provide information to the masses.

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(5) The Need for Explicit Instructional Design Paradigms

Wendy Thompson

Instructional design responds to the complexities of instruction in numerous, unique ways. Though the goal of each domain of instructional design is to maximize the instructional intervention, however, paradigms that conceptualize learner-centered instruction have yet to address culture and its importance in the instructional process.

Education is a social system. Like other social systems, it mirrors attitudinal change over time. Qualitative research's challenge to the preeminence of quantitative research in academic literature (see Bogdan & Biklen, 1992) and the shift from chalkboards to computers in the classroom illustrate this assertion.

America, once perceived as "The Great Melting Pot," preached Americanization by assimilation. The attempt was made to strip away or minimize ethnicity; an amalgam of people was to make one America. The relatively new immigration and a surge in cultural pride, however, challenged America's historical assimilationist paradigm, fostering the perception of this country as a mosaic. Each tile with its own shape, size, and color made a contribution to the beauty of the overall picture. This, according to Scheel and Branch (1993) constitutes cultural pluralism, a concept which "reflects the recognition that cultures have no inherent hierarchy of truthfulness; that is, patterns of behavior and thinking yield a multiplicity of perceptions of the world which are no more or less verifiable than others" (p.7). Cultural pluralism may be seen as the ultimate goal evolving from a diverse population.

While the country – and the world for that matter – had undergone a major paradigmatic shift on a macro social level, a shift of this magnitude had yet to take place on a micro level within education, a field which has been traditionally assimilationist. The culture of those involved in the educational process was not a determinant factor, because the primary goal of education was the mainstreaming of all groups. The assimilationist educator, then, may have advocated English as a second language instruction not for the enrichment of the students, but as a quick-fix to get immigrants to become literate English speakers (Janzen, 1994). The acceptance of the tenets of instructional design over the years has gradually minimized instances of outmoded, teacher-centered instruction.

While instructional design itself is being accepted more readily, educators appear to be reticent in incorporating the cultural renaissance into instructional planning. Instructional design paradigms remain stagnant in the face of sweeping cultural reform. The culture of all participants within the instructional intervention should be made more explicit. Models are needed to reflect culture's presence.

Presently, educational technologists are functioning on a type of honor system. One is left to assume that cultural elements are included in instruction. Banks' Four Levels of Implementation (1989) describes the depth of inclusion of culture in curricula. Level I, Contributions, acknowledges non-mainstream contributions, highlighting individually distinct elements, such as heroes, holidays, and foods. Level II, Additive, allows for the insertion of content, themes, and perspectives of cultural groups into the curriculum; basic curricular structure remains unchanged. At Level III, Transformation, structural changes to the curriculum allow for the inclusion of concepts, issues, and events viewed from the perspective of the cultural group. Level IV, Social Action, appears to be the most self-actualized level of the paradigm. Students decide on social issues involving cultural groups and act constructively to solve them. Presently, most curricular inclusion of culture occurs at Level I. Quaint observations of holidays, sampling of different foods, and exhibitions of native dress suffice for the inclusion of culture in curricula. Instructional design models currently in use accommodate this implicit inclusion.

Instructional designers should be mindful of the position that learning occurs like Lego® blocks, building on itself to form new ideas. The more attractive the block, the greater the chance that it will be snapped from short term memory snugly into place in long term memory, to last ad infinitum. Chunking and the acceptability of messages increase exponentially the opportunities for these blocks to snap together and last, ensuring that learning has occurred (Gagné, Briggs, & Wager, 1992; Gredler, 1992). Common sense dictates that messages coming from a messenger that most resembles the learner would make the message more attractive and would hasten its adherence to the learner's schema. This principle is one of the basic foundations of culturally pluralistic instruction.

One may ask, "What's the solution, then, to including culture in instructional design?" Is in tweaking models such as Dick and Carey by merely adding another box? Is it in reshuffling and adding another event to Gagné's already existing nine? Or is it in totally discounting present instructional design models altogether? General system theory is one of the informants of instructional design (see Dick & Carey, 1996); basic systems theory states that entropy is inherent in all systems. Models of the past have nobly served their purpose in the systems for which they had been designed. However, those systems are breaking down, making way for a new culturally pluralistic world order. The time has come for new instructional design models that conceptualize and reflect this change. A new generation of instructional designers appears ready to rise to the challenge of their creation.

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(6) An Evaluator Considers the Cultural Sensitivity of Instructional Materials

Thomas C. Reeves, Ph.D.

Is cultural sensitivity a serious issue in the design, dissemination, and evaluation of instructional programs and products for international markets? Some might argue that cultural sensitivity is just a passing "fad," a by-product of the current attention to multiculturalism within North American and European academic institutions. I disagree. Sensitivity to cultural diversity and pluralism is a "meta-value" that should influence virtually every aspect of human activity, including instructional systems design.

The rationale for including cultural diversity as a critical factor in evaluating instructional programs and products goes to the heart of the challenge of making evaluation a legal and ethical process. Scriven (1993) describes ethical, legal, and ecological standards as "value absolutes" that must not be violated when evaluating the merit and value of programs and products. For example, practical criteria for evaluating computer-based training (CBT) may include costs, but an ethical absolute would be paramount if it was found that the CBT delivery system released cancer-causing emissions. Cultural sensitivity should be added to the list of value absolutes. Attention to issues involved in cultural and ethnic diversity are not "nice to have" criteria, but essential elements in the evaluation of education and training. The importance of this absolute is heightened in the 1990's as more and more commercial and academic institutions seek to market instructional systems around the globe.

Any instructional designers and evaluators who have worked internationally or with minority populations in their own countries can identify examples of instructional programs, products, or methods that are culturally insensitive. For instance, when I was in Taiwan several years ago, I met the president of a large electronics company who was interested in providing ESL (English as a Second Language) instruction for his employees and their children. This entrepreneur was convinced that computer-based instruction could play a significant role in this undertaking, but he was disgusted with the cultural bias of commercial ESL materials he had purchased from the USA and the UK. "These programs ignore the importance of the family in Chinese culture," he complained. As an illustration, he showed me a writing assignment from one program. Students were supposed to complete a paragraph that began: "Johnny is worried about going home today because his mother's boyfriend is coming to dinner for the first time. Johnny feels...." The insensitivity of this exercise to Chinese cultural norms needs little explanation.

Ironically, the designers of this ESL exercise may have been trying to be sensitive to learners who came from broken homes, consciously deciding to place Johnny in a dilemma which is not unfamiliar in some Western societies. While this exercise might have been appropriate for some cultures, marketing these materials to another culture without considering the appropriateness of this scenario in that other culture is an insensitive act.

Cultural sensitivity is often a subtle issue, and it is very naive of instructional designers and evaluators to imagine that they can detect cultural insensitivities on their own. While some checklists or rating scales may assist designers and evaluators in catching glaring examples of cultural insensitivity, the collaboration of representatives of each target culture is necessary to identify less obvious sources of cultural bias. Andrews (1994) provides numerous examples of the hidden nature of cultural bias within a South African context. For example, Andrews' paper includes a graphic of a boy kissing his mother from a computer-based language lesson. The picture had to be changed to that of a mother kissing a boy when a Zulu-speaking member of the development team indicated that it is inappropriate for a boy to kiss his mother in the Zulu culture. Andrews also points to the common use of heads and hands as icons in multimedia; these are seen as taboo images of severed body parts in some African cultures. Leh (1996) illustrates other examples of the cultural insensitivity of multimedia design factors from an Islamic perspective. For example, the common use of animals as metaphors for people in "edutainment" software for children can be highly insulting to Muslims, especially animals such as dogs, pigs, and rats.

Even core pedagogical values in one culture may be culturally insensitive in another. An "advanced" science education curriculum for primary children developed by the ministry of education in an Australian state stresses the asking of "Why?" questions. This same curriculum contradicted cultural traditions within some Aboriginal communities in which asking "Why?" to an elder such as a teacher is considered highly insolent. The solution may not be in eliminating "Why?" questions from the science curriculum, but extra attention to how innovative pedagogical strategies are introduced into minority cultures is required.

There is not room in this brief presentation to describe all the ways that evaluators and others can include cultural sensitivity as a meta-value in their evaluations of instructional materials. Further, we hardly know enough about this important issue to delineate all the ramifications of this process. In fact, this is an area in much need of creativity and research. At the same time, it is important to point out that cultural sensitivity is not just a matter of identifying and eliminating cultural bias. The culturally sensitive instructional designer and evaluator should be proactive by seeking opportunities to increase the cultural relevance of instructional materials and to build upon cultural diversity and pluralism. Our ultimate goal should not be designing culturally neutral instructional materials, but creating learning environments that are enriched by the unique values that are inherent in different cultures. This is much easier said than done, but it is one of the most important challenges faced by educational technologists as we approach the 21st Century.

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Title:

An Assessment of Retention and Depth of Processing Associated with Notetaking Using Traditional Pencil and Paper and an On-line Notepad During Computer-Delivered Instruction

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Abstract

This study examined the role taking notes using either pencil and paper and an on-line computer notepad during computer-delivered instruction have on retention and depth of processing. The results of this study can be summarized as follows: 1. There was a difference in total post-test scores between the control group which took no notes and the treatment group which took notes on-line. The difference, which supported on-line notetaking, appeared to be due to the way the control and on-line notetakers answered the factual-type questions on the post-test; 2. The type of notes taken did not affect the overall retention of information; 3. The method used to take notes and the type of notes taken did not affect the number of idea units recorded by the subjects; 4. A difference in recall scores was found between the verbatim and both the own style and paraphrase notetakers. It supported the verbatim notetakers; 5. There was a positive correlation between the recall scores and total post-test scores of the subjects.

Introduction

The perception by both educators and students that notetaking is a powerful strategy which enhances recall and learning from lecture and text is supported by research. To date, most notetaking research has centered around the encoding and external storage functions of notetaking as first proposed by Di Vesta and Gray (1972). The encoding hypothesis suggests that notetaking serves to increase the learner's attention during lecture or when reading from text, thereby encouraging learners to integrate and elaborate upon what they hear, see, or read with their prior knowledge. This, in turn, increases the chances of encoding the noted information in long-term memory.

The external storage function, on the other hand, asserts that notes themselves are beneficial only when used as a review tool. In other words, the process of taking notes is not important in recall and retention. It is only the product, the notes themselves, when employed for review, that are important.

In reality, students most likely take notes because of both the encoding and storage functions of notetaking (Hartley & Davies, 1978). In other words, students take notes to maintain a written record of what occurred in lecture or text and later use this record to enhance review. The benefits of the notetaking plus review strategy has been well documented. In studies where notetaking-only groups have been compared to notetaking-plus-review groups and no-notes groups, in general, the notetaking-plus-review groups yielded superior recall (Fisher & Harris, 1973; Carter & Van Matre, 1975; Rickards & Friedman, 1978). In a review of 26 notetaking comparison studies, Ganske (1981) consistently found that students who took notes outperformed those who did not take notes on recall tests when a period of time was provided to review notes. Instead of trying to isolate whether the encoding or storage function is more significant, it may be of more importance to focus on the type of information included in notes which may be indicative of the level of processing used to produce the notes as well as their utility as a review tool.

The movement from behaviorism to cognitivism has significantly influenced the design of instruction delivered via computers. The emphasis has moved from using the computer to deliver simple page turning software to software which encourages learners to actively participate in instruction through lesson sequencing options, embedded questions and answers, predicting and hypothesizing, and customized, specific feedback (Hannafin & Reiber, 1987; Yankelovich & van Dam, 1985; Grubaugh, 1985; Neuwrith, C. M. Kaufer, D., 1987).

Today notetaking applications available on microcomputers range on a continuum from utility-type applications, such as calendars or note-posting options, to sophisticated hypertextual applications used to facilitate recording, organizing and manipulation of the notes.

There are several similarities between computer and text based learning environments. Most computer-delivered instruction and prose offer learners the ability to:

- move to previous prose for additional review and clarification;
- reread passages until they are understood;
- attend to information at a pace determined by the learner;
- use cues such as layouts, formats or heading embedded in the text as visual aids to help determine important information.

Lecture environments on the other hand, require learners to follow at a pace determined by the instructor which, according to Peters (1972), may be at a rate up to 180 words per minute. If visual aids are not used, students in lecture environments must often rely only upon verbal inflections for cueing. The similarities between learning from prose and from computer-delivered instruction suggest that research methodologies used to assess notetaking from text may be helpful in evaluating the role of notetaking during computer-delivered instruction.

Although the research supporting the utility of notetaking in the prose environment, which is similar to that of the computer-delivered instructional mode, is very positive, there exists a scant amount of research which examines the role of notetaking using either pencil and paper or a computer during computer-delivered instruction itself.

In research related to computers and notetaking, Novellino (1985) compared computerized notetaking and notetaking using pencil and paper in a lecture environment. Subjects were divided into four groups based on notetaking method (computerized and pencil and paper) and gender. Each subject listened to four lectures and recorded notes during each session using one of the methods assigned. After each session a post-test was administered in which the recall of total words, key words, and ideas were assessed. The results indicated that notetaking using pencil and paper yielded greater recall for subjects who were poor typists while notetaking via a microcomputer resulted in greater recall for skilled typists. Significant differences in the time required to complete the lesson favored groups using the microcomputer. No attempt was made to examine the notes themselves to determine if the computerized method facilitated greater assimilation, elaboration, or reorganization on the part of the subjects.

Only one study was located which examined the role of computerized notetaking as an integral part of a lesson delivered via the computer. Wambaugh (1991) assigned undergraduate students to one of these three random treatment conditions during the computer-delivered instruction:

- a control group which was allowed to take no notes;
- a group which created notes using a computer and stored them in a computerized note file;
- a group which captured notes from the instruction by highlighting and copying them to a computer note file.

Wambaugh reported three major findings of this study. First, learners who created their own notes during computer-delivered instruction experienced a significantly higher level of achievement on both immediate and delayed post-tests than learners who captured notes. However, the group that created their own notes did not outperform the control group who took no notes. Second, there was no correlation between either the immediate and delayed post-tests scores and the number of words in the computerized note files created by the two groups of notetakers. Third, there was no correlation between achievement on either the immediate or delayed post-tests and the number of ideas recorded in the subjects' notes which were tested.

Wambaugh contended that no correlations between the immediate and delayed post-test scores, the number of words in the note files, and number of ideas tested may be due to the type of achievement test administered. Both tests required the learner to type responses as a phrase or few words rather than select the correct answer from a list of possible answers. Also, the computer delivery system did not allow learners to look back at previous questions for possible clues.

This study supported the depth of processing hypothesis which contends that the more learners interact with new material in an attempt to make it their own, the more likely it is to be retained in memory. This was accomplished during the study by allowing learners to create their own notes. Unfortunately, Wambaugh did not examine the notes to determine the degree or depth to which students did process the information.

Three observations related to notetaking research in general influenced the design of the present study. First, the duration of most reported notetaking studies has been very limited. Research studies involving notetaking during lecture were often limited to a 50-minute class period or less, while research from prose was often restricted to taking notes from passages that were less than 2,000 words in length. It is questionable whether such research settings represent realistic notetaking situations (Howe, 1974; Hartely & Marshall, 1974).

Second, although Wittrock (1974, 1978) has suggested that benefits are gained from notetaking when learners generate paraphrased notes which incorporate prior knowledge, few research studies have attempted to examine the notes themselves to determine if generative notes are in fact routinely taken by learners. Most research simply assumes that when instructed to take paraphrased notes, subjects produce notes which reflect a deep level of processing (Ganske, 1984; Kiewra, 1987).

Finally, most research related to notetaking has been done utilizing lectures and prose. Although several researchers have indicated the potential benefit of notetaking during computer-delivered instruction (Hannafin, 1989; Kozma, 1987; Jonassen, 1988), little research has been undertaken to assess its merits or to evaluate the use of new procedures available to take notes on-line.

The current study attempted to expand for students, educators, and software designers, the limited research base related to computer-delivered instruction and notetaking by addressing the aforementioned research issues through:

- involving the subjects in notetaking during computer-delivered instruction weekly for a period of four weeks;
- using a computerized notepad as well as pencil and paper as mediums to record notes;

- assessing the generative process of notetaking by evaluating weekly the content of the three types of notes (own style, verbatim, and paraphrase) recorded by subjects using pencil and paper and an on-line notepad.

Procedures

Subjects

The sample (N = 112) consisted of junior and senior undergraduates from a southern Minnesota university whose major was computer and information science. Subjects with this major were selected to participate in the study because their discipline required significant time using computer technology. This also assured that all subjects had adequate experience with computers prior to the study, thus minimizing the potential novelty effect often associated with computer-related research.

Students who participated in this study were enrolled in a computer and information science course during the study period. Participation in the study was part of their assigned course work for the quarter. Their performance on the post-test measure did not impact the grade they received in the course.

All students completed a questionnaire prior to the start of the study. Students who indicated they had no prior knowledge of the technical aspects of IBM's AS/400 minicomputer system and had worked extensively with microcomputers and word processing applications were eligible for the study. Based on these criteria, 21 subjects from the original pool of 133 were omitted from the study leaving 112 final participants.

Materials

Tutorial. This study required participants to view modules from the AS/400 tutorial and take notes from the modules using either pencil and paper or an on-line computer notepad. These modules were selected: Operating System and Architecture Support, Equipment Overview, Control Language Structure, Attachment of Personal Computers and Other Devices. Based on the observations conducted using a similar student sample to view these modules, it was estimated that each module would take approximately 40-60 minutes to view.

A week after the subjects finished the modules, each participant completed an exit questionnaire and took a post-test.

Idea units. Idea units contained in each of the modules viewed by the subjects were determined. An idea unit was defined as a single complete idea or single block of information (Bransford & Johnson, 1972). A total of 32 idea units from the four modules were selected. These idea units served as the basis for assessing notes.

Post-test. The achievement post-test consisted of 40 questions: 22 multiple-choice, 13 fill-in-the blank, and four true/false. The questions included 32 factual and eight synthesis-type questions. The test was completed using paper and pencil. All groups, except the control group who viewed the modules and took no notes, were allowed to review their notes prior to the test. The control group was allowed to mentally review the content of the modules. The reliability of the post-test instrument was .78 as determined by a KR-20 statistical procedure.

Exit questionnaire . This served as a tool to elicit the amount of time subjects spent reviewing prior to the post-test and their preference for text-based or computer-delivered instructional format

Treatment

Subject groups. The subjects participating in the study were randomly assigned to groups which served to assess the benefits of both the notetaking method (pencil and paper, on-line notepad, or no notes) and the type of notes taken (own style, verbatim, or paraphrased).

Those subjects who were assigned last digits from one to seven participated in the study and their data was used in the analysis of the research. Those subjects who were eliminated from the study due to responses on the pre-study questionnaire were assigned a last digit of eight. This group completed the modules and took the post-test, but their data was not used in any phase of the analysis.

The following list identifies the significance of each of the eight digits used to identify the group assignment of each study participant:

1--served as the control group, only viewed the modules and took no notes;
2--took notes using their own notetaking style with pencil and paper;

3--took verbatim notes with pencil and paper;

4--took paraphrased notes with pencil and paper;

5--took notes using their own notetaking style with the on-line notepad;

6--took verbatim notes with the on-line notepad;

7-took paraphrased notes with the on-line notepad;

8--data not used in the analysis, took notes from modules two and four using any method and type of notes.

For purposes of data analysis, each subject in this study had membership in two groups associated with the method and/or type of notes taken. First, three *notetaking method groups* included subjects who took no notes, notes using pencil and paper, or notes using the on-line notepad. No regard was given to the type of notes taken.

Second, three *note-type groups* included subjects who, regardless of the notetaking method used for notetaking, took verbatim, paraphrased, or notes using their own notetaking style. The three note-type groups, of course, did not contain the control group.

Notetaking methods. Those subjects who, as part of their treatment, took notes on-line, used a computerized notepad which could be opened at any time with a single keystroke. Participants could simultaneously view a module screen and record information on the notepad. The computerized notetaking pad consisted of a scrolling window that had the same formatting, editing, printing, and copy/paste capabilities as a word processor. The notepad was also dynamic; it could be sized and repositioned on the screen at any time. At the end of each module this group was required to print out a copy of their notes for evaluation by the researcher. To discourage uncontrolled review of notes, subjects were asked not to save their notes on electronic media after printing.

Subjects who were required to take notes using pencil and paper supplied these materials for recording notes during each module. They also submitted their notes to the researcher after viewing each module.

Monitoring subject participation. Participants were instructed to complete the review of one module and the related notetaking, if assigned, at one sitting. Weekly reports were obtained from the AS/400 system administrator at the university which listed the name of each subject who accessed the required module during the assigned period and the number of times each module was accessed by the individual. This served to confirm that all research participants, including the control group, did in fact view the assigned modules and all viewing of a module was done in a single session.

Procedure

Training session. Prior to the actual study, each research subject participated in a two-hour training session designed to:

- describe the study and its purpose;
- identify the responsibilities of each participant during the study;
- review the criteria and benefits of good notes regardless of the medium;
- define and provide examples of what is meant by paraphrased, verbatim notes, and individual notetaking styles;
- define the objectives for each module used in the study;
- provide hands-on experience accessing the AS/400 tutorial modules and the on-line notepad.

Four such sessions were conducted in one day. Each training session contained subjects who had been assigned randomly to different treatment conditions. Time was allowed for questions and clarification.

Weekly note evaluation. During the study, all groups viewed a different module each week for four weeks. All subjects, except for the control group, took notes related to the modules using their assigned method and note-type. Because of the accessibility of computers and network efficiency, the weekly viewing/notetaking could be completed by the subjects at any time during the week assigned to that module. After the notes were completed, they were submitted to the researcher for evaluation. In addition, all subjects were required to record and submit their start and stop times for viewing and taking notes from each module.

The weekly evaluation procedure consisted of two tasks. First, each subject's notes were examined to determine if they were produced using the specified note-type (paraphrase, verbatim, or own style) assigned to that subject. Interestingly, during the course of the study, all subjects recorded notes using their assigned types. Second, each subject's notes were examined to determine the number of idea units and to identify which idea units were present. This information, as well as the self-reported time used to view and take notes from each module, was recorded weekly for each subject.

Post-test. One week following the completion of the last module, an exit survey and post-test were administered. Prior to the post-test, the subjects had an open-ended review period. During this period, subjects who had taken notes had their notes returned and were allowed to review them for a minimum of five minutes up to twenty-five minutes. The control group was allowed the same amount of time for mental review. The time used by each subject for review was recorded.

Each post-test was evaluated and the following scores were noted:

- number of correctly answered factual-type post-test questions;
- number of correctly answered synthesis-type post-test questions;
- total number of correctly answered questions;
- recall score which was defined as the correctly answered questions which had corresponding idea units recorded in the subject's notes.

Results

This study addressed the following research questions:

- does using an on-line computer notetaking device during computer-delivered instruction significantly enhanced learning;
- does taking paraphrased notes during computer-delivered instruction promoted greater recall than verbatim notetaking or notes taken using the subject's own notetaking style;
- are recall scores were affected significantly by the method and/or type of notes taken.

This study was a 2 x 3 factorial design with a control group. The independent variables are the notetaking tool used (notepad or pencil and paper) and note-type (paraphrase, verbatim, or own notetaking style). The control group took no notes while viewing the computer-delivered instruction.

The dependent variables include total post-test score, correctly answered post-test factual and synthesis-type questions, recall score, and number of idea units recorded.

Results Related to Research Question 1

The results of an ANOVA for notetaking method groups (C, PP, OL) and total post-test score variable a difference between the post-test scores of the group members (F(2, 109) = 3.17, p = .046) (Table 1).

Table 1

ANOVA for Notetaking Method Groups and Total Post-Test Score Variable

Source	*df*	*SS*	*MS*	*F*	*p*
Between		204.55	102.27	3.17	.046*
Groups	2				
Within Groups	109	3517.87	32.27		
Total	111	3722.42			

*p < .05

Further examination using the Fisher LSD procedure identified a difference between the control group and the on-line group's post-test scores.

A one-way ANOVA revealed no difference between the correctly answered post-test synthesis-type questions of the notetaking method groups (*C, PP, OL*) (F(2, 109) = 0.36, p = .698).

A one-way ANOVA did reveal a difference between the correctly answered post-test factual-type questions (F(2, 109) = 3.74, p = .027) (Table 2).

Table 2
ANOVA for Notetaking Method Groups and Post-Test Factual-Type Question Score Variable

Source	*df*	*SS*	*MS*	*F*	*p*
Between Groups	2	166.97	83.48	3.74	.027*
Within Groups	109	2433.60	22.33		
Total	111	2600.56			

*$p < .05$

A follow-up Fisher LSD procedure identified a difference between the way the control group and the on-line group responded to factual-type questions.

Results Related to Research Question 2

Two-way ANOVAs were used to examine whether paraphrased notes promoted greater retention than verbatim notes or notes taken using an individual's own notetaking style.

The total post-test scores, post-test synthesis-type questions scores, and post-test factual-type questions scores of the notetaking method groups (*PP, OL*) and the note-type groups (*O, V, P*) were used to assess the ability of the subjects to retain information.

This procedure showed that there were no differences between their post-test scores (notetaking method groups $p = .150$ and the note-type groups $p = .306$). There was no interaction between the two groups ($p = .670$).

A 2 X 3 ANOVA was used to test for differences between the post-test synthesis and factual-type question scores of the notetaking method groups (*PP, OL*) and the note-type groups (*O, V, P*) . This procedure showed no differences between the mean post-test synthesis-type question scores of the notetaking method groups ($p = .778$) or the note-type groups ($p = .051$). There was no interaction between the two groups ($p = .735$). A two-way ANOVA showed no significant difference between the post-test factual-type question scores of the notetaking method groups ($p = .098$) or the note-type groups ($p = .283$). There was no interaction between the two groups ($p = .651$).

Results Related to Research Question 3

A 2 x 3 ANOVA was used to test for significant differences between the total idea units of the notetaking method groups (*PP, OL*) and the note-type groups (*O, V, P*). This procedure resulted in no significant differences between the mean number of idea units recorded by the notetaking method groups ($p = .663$) and the note-type groups ($p = .052$). There was no significant interaction between them ($p = .879$).

A 2 x 3 ANOVA was used to test for differences between the recall scores of the notetaking method groups (*PP, OL*) and the note-type groups (*O, V, P*) . This procedure indicated that there was a difference between the recall scores of the note-type groups ($p = .002$) but no difference between the recall scores of the notetaking method groups ($p = .064$). There was no interaction between the groups ($p = .616$).

Table 3
Two-Way ANOVA between Notetaking Method Groups and Note-Type Groups for Recall Score Variable

Source	*df*	*SS*	*MS*	*F*	*p*
Explained	5	470.88	94.18	3.55	.006
Residual	87	2309.57	26.55		
Total	92	2780.45	30.22		

Source	*df*	*SS*	*MS*	*F*	*p*
Notetaking Method	1	93.68	93.70	3.53	.064
Note-Type	2	346.18	173.09	6.52	.002*
NM*NT	2	25.86	12.93	0.49	.616

* $p < .05$

A Fisher LSD procedure was run on the total recall scores of the note-type groups. The results indicate differences between verbatim notetakers and both notetakers who used their own style and paraphrase notetakers.

A Pearson Correlation coefficient between recall scores and post-test scores for all subjects in the study who took notes was .6867 ($p<.01$).

The results of these analyses can be summarized as follows:

1. There was a difference in total post-test scores between the control group which took no notes and the treatment group which took notes on-line. The difference, which supported on-line notetaking, appeared to be due to the way the control and on-line notetakers answered the factual-type questions on the post-test.
2. The type of notes taken did not affect the overall retention of information.
3. The method used to take notes and the type of notes taken did not affect the number of idea units recorded by the subjects.
4. A difference in recall scores was found between the verbatim and both the own style and paraphrase notetakers. It supported the verbatim notetakers.
5. There was a positive correlation between the recall scores and total post-test scores of the subjects.

Discussion

Research Question 1

It was predicted that computerized notetaking would elicit greater learning during computer-delivered instruction than taking notes with pencil and paper or taking no notes. Comparisons between the notetaking method groups' total post-test scores, factual-and synthesis-type post-test question responses, and the post-test questions associated with each module were used to assess this hypothesis.

The total post-test score analysis of the notetaking method groups determined a difference did exist between the post-test scores of the on-line and control notetaking methods groups.

Further evaluation also revealed an overall difference in the number of correct responses to factual-type post-test questions by these same two groups, the control and the on-line, while no difference was found between the notetaking member groups' responses to the synthesis-type post-test questions.

Differences in total post-test scores. Two related explanations exist as to why subjects who took notes on-line performed significantly better than those who took no notes.

The first explanation is related to the length of the study. There was a period of five weeks between the time subjects viewed the first tutorial module and the administration of the post-test. Given the duration of the study, it should not be surprising that taking notes and reviewing them prior to testing increased retention more than not taking notes and reviewing only mentally. This finding is consistent with other notetaking research which concluded that taking and reviewing notes was more beneficial to recall than taking no notes and using only a mental review to prepare for evaluation (Kiewra, 1985, 1989; Rickards & Friedman, 1978).

Second, in addition to providing a method to record notes for review, taking notes using the on-line notepad may have provided subjects with a more efficient way to:

- include information in notes;
- organize information in a meaningful manner;
- reduce fatigue which may occur while taking notes using pencil and paper.

These potential advantages, in turn, may have encouraged the on-line subjects to take better, more succinct notes, which may have benefited them during review and testing.

Differences in factual post-test scores. The difference in the total post-test scores of the control and the on-line groups were to a great extent due to the difference in the way group members answered the factual-type, low-level questions rather than the high-level, synthesis-type questions. Two factors may have influenced the subjects' responses to this question type. First, the subjects may have been interacting at a novice level with the subject matter presented in the modules. That is, they may have lacked the subject matter depth and breadth to be effective at integrating prior knowledge with the information presented in the tutorial modules. This could have hampered their efforts to respond to the synthesis-type questions. The subjects may have been more efficient and effective at being able to recall information than integrate information, and, in turn, use this information to solve problems.

Second, eighty percent of the post-test questions were factual. The remaining were synthesis-type questions. Perhaps a more equitable number of both question types would have presented a clearer picture of the relationship, if any, between the notetaking methods used in the study and the impact of these methods on responses to factual and synthesis-type post-test questions (Jonassen, 1984; Rickards & Friedman, 1978).

Research Question 2

It was predicted that paraphrased notes taken during computer-delivered instruction and reviewed prior to testing would promote greater recall than verbatim notes, or notes created using an individual's own notetaking style. Paraphrased notetaking was anticipated to be a generative activity which encouraged subjects to consciously and intentionally relate new information to existing knowledge, thereby enhancing retention.

To evaluate this hypothesis, the note-type groups' total post-test scores, factual-and synthesis-type post-test scores were examined.

In the note-type groups, this study identified no differences between the total post-test score, factual-type and synthesis-type post-test question responses of the subjects.

These findings are contrary to the other notetaking depth of processing research (Shimmerlik & Nolan, 1976; Bretzing & Kulhavy, 1979; Bretzing & Kulhavy, 1981; Jonassen, 1984). Wittrock's generative learning (1974, 1979) model asserts that learners who actively engage in building associations between that which is known and that which is to be learned create a greater number of associations, which, in turn, enhances recall.

Lack of differences in total post-test and factual-type, and synthesis-type post-test question scores by the note-type groups. Two possible explanations exist for the performance of the note-type groups on the post-test and its component question types. Although the notes for each subject were examined weekly to ensure participants recorded notes that were either paraphrased, verbatim, or recorded using their own style, no determination was made as to the amount or depth of processing done by the learner producing the paraphrased notes. It was assumed by the researcher that additional processing took place. According to Wittrock's generative hypothesis, unless the learner makes use of his or her own knowledge for interpreting incoming information, the process is not generative. Wittrock contends that if the processing is not generative, the associations that are formed will not be as distinct, so less meaning will be generated from the information. It is possible that when paraphrasing notes, this group simply did not engage in processing to the extent suggested by Wittrock's model.

Second, the composition of the post-test, with a large percentage of factual-type questions and limited number of synthesis-type questions, may not have been the optimum format to elicit responses which assess the result of generative learning. A free recall testing format or additional synthesis-type questions may have been more successful at assessing whether paraphrased notetaking promoted more learning than other forms of notetaking (Jonassen, 1984; Rickards & Friedman, 1978).

Research Question 3

It was predicted that information present in notes taken during computer-delivered instruction had a significantly greater chance of being recalled than information not recorded in notes. Previous notetaking research has concluded that when idea units which serve as the basis for post-test questions were present in a subject's notes, the subject had a greater chance of recalling that information than information not recorded in notes (Crawford, 1925b; Howe, 1970; Fisher & Harris, 1973; Kiewra & Fletcher, 1984; Bretzing & Kulhavy, 1981). Both the number of idea units and recall scores calculated using the weekly work submitted by the notetaking method groups and the note-type groups were used to evaluate this hypothesis.

No differences were found in the total number of idea units recorded by the members of the notetaking method groups or the note-type groups.

Differences in the recorded idea units associated with the following modules and groups were found between:

- the verbatim notetakers and both the own style and paraphrase note-type group members in modules one and two;
- the on-line and pencil and paper notetaking methods groups members in module four.

The purpose of examining the recall scores for subjects in this study was to assess what impact recorded idea units had on retention.

Overall, a difference did exist between the total recall scores of the verbatim note-type group and both the own style and paraphrase note-type groups which favored the verbatim group.

Lack of difference in total idea units. Since no overall difference existed in the number of idea units present in the notes of the notetaking method groups or the note-type groups, it may be concluded that neither the methods used to take notes (on-line notepad or pencil and paper) nor the type of notes taken (own style, verbatim, or paraphrase) influenced the number of idea units recorded in notes. The research participants were apparently able to identify the important ideas as well as record them regardless of the method or type of notes required.

Although there were no differences in the number of idea units among the groups, there were differences between the recall scores of the verbatim note-type group and other group members. Since recall scores were calculated by determining the number of correctly answered post-test questions which also had corresponding idea units present in the subject's notes, one should ask what the verbatim notetakers included in their notes or did in addition to recording the idea units which enhanced their recall. The answer, perhaps, is in the very nature of notes taken, namely the verbatim notes.

Subjects who were asked to take verbatim notes were told during the pre-study training session that the notes should contain exact, precise information about the content of the module. Such structured information in the subjects' notes may have helped them review more effectively for predominantly low-level, factual type questions because their notes had the correct, detailed information for review.

Correlation between recall score and post-test score. The significant positive correlation between recall scores and post-test scores solidifies the importance of recording notes and having them available for review.

Recommendations for Further Research

Several of these questions suggest opportunities for future research. They include

1. What factors were responsible for the overall success of the on-line notetaking group? Were these factors cognitively based or were they associated with the attributes of the on-line notepad which allowed the user to easily record, organize, and read information once it has been recorded?

2. Is there one type of notes (i.e. verbatim, paraphrase, or own style) which is better suited for low-level or high-level items? Is the success of the verbatim notetakers on tests of factual detail due to the process of recording information or due to the completeness of the notes which were later used in the review process?

3. What level of computer expertise must be reached before an on-line notepad can be used easily and confidently by the learner? Does a subject's attitude towards new technologies and their use of such technologies affect the learner's desire to use an on-line notepad for notetaking?

4. At what age can a learner effectively take notes and use them as a useful learning strategy, a resource for study and review? At what age and subject-level mastery are learners capable of generating paraphrased notes? This study assumed that the subjects knew when material should be included in notes. What strategies could be incorporated into computer-delivered instruction to alert younger learners when important information, which perhaps should be included in their notes, is presented ?

5. Does the medium used to deliver instruction affect the success of the notetaking method? For example, assume that the content of the tutorial modules used in this study was available on paper as well as on the computer. Will on-line notetaking produce similar results using the paper format as it did using the computer?

6. By allowing subjects to both take and review their own notes, this research supported both the process and product functions of notetaking during computer-delivered instruction. Does taking notes either on-line or with paper and pencil during computer-delivered instruction benefit students who are allowed to only record notes without the opportunity to review them?

7. Do notetakers outperform non-notetakers when the number of modules and the time required to complete them is either increased or decreased? Does a delay period between viewing modules significantly affect retention?

8. Given that an on-line notepad is required for on-line notetaking, are there elements associated with the on-line notepad's interface design which could be modified to encourage use even by novice computer users?

9. There has been no research done which assesses the merits of cooperative notetaking during computer delivered instruction. Is cooperative notetaking beneficial to those involved? Is it most successful when notetaking is viewed as a process, a product, or a combination of both? What are problems that arise with this method? Are notes recorded with pencil and paper or on-line prove most beneficial? Do cooperative groups encourage learners to generate paraphrased notes?

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Title:

The Effects of Group and Task Structure in an Instructional Simulation

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Abstract

Computer simulations allow students to explore learning environments by forming hypotheses and making and testing predictions. A dilemma in designing such simulations is how to provide a challenging exploratory environment and yet provide sufficient student support so that students do not become lost. Directive support such as corrective feedback may detract from the exploratory quality of a simulation. Two methods of non-directive support are 1) simplifying the initial presentation of the simulation by having the student manipulate only some of the variables and 2) presenting the simulation problem to a small group rather than to individuals so that students may give each other feedback on their hypotheses and procedures. This paper examines the effect of both of these methods and their interaction upon undergraduate students solving a problem in a four variable computer simulation of the spread of an epidemic.

Subjects were divided into four treatment groups: individuals working with reduced initial complexity, individuals working with full initial complexity, groups working with reduced initial complexity, and groups working with full initial complexity. In terms of the effectiveness of instruction as measured by the percentage of students reaching a correct solution, a significantly greater proportion of subjects who worked individually reached the correct conclusion when the task was initially simplified. In contrast, a greater proportion of subjects who worked in groups reached the correct conclusion when presented with full initial complexity.

Subjects performed significantly more simulation runs when they were first presented fewer variables and finally all of the variables. When a task is complex individuals may benefit from working with a group. In this study group work provided no benefit for the simplified task. The study suggests it may be preferable, in presenting a complex, multi-variable simulation, to present it to groups for solution rather than attempt to break it down into component parts.

With increasing emphasis on constructivist approaches to learning and greater availability of appropriate software, instructional computer-based simulations are increasingly being used to allow students to explore complex multi-variable phenomena by manipulating variables and observing changes. For example, Smithtown allows students to vary economic variables (wages and prices) and observe outcomes, such as shift in the demand function (Shute & Glaser, 1990). MIDAS, a simulation in the domain of decision-support theory, requires users to see the effects of specifying different weights on user preference scores (de Jong, de Hoog, de Vries, 1993). REFRACT allows students to see the effects of manipulating variables such as optical density, angle of refraction, and image distance on objects such as surfaces, lenses and rays (Reimann, 1991). Numerous such simulations now exist in both the physical and social sciences. Common to all of them is the process of experimentation, which includes forming hypotheses, making and testing predictions, and modifying the hypotheses. A dilemma is that this process, basic to scientific inquiry, is both a prerequisite for and an outcome of using such simulations. Some simulations have been used in an attempt to teach the methods of scientific inquiry, for example Discovery Lab (Minnesota Educational Computing Corporation, 1984). But more often, as in the examples above, the main purpose is to teach content, namely, the relationships of variables defining a physical or social phenomenon.

While it is widely believed that simulations can effectively teach about complex systems through this controlled method of discovery, studies have demonstrated that not all students meet with success (e.g. Shute & Glaser, 1990; Njoo & De Jong, 1991). Learning in such environments requires students to construct their own knowledge and is generally very demanding for students, even with some form of instructional support. However, the provision of such support needs to be considered in terms of its effects on the nature and level of learners' exploratory strategies. Ideally, such support should facilitate student learning while maintaining the exploratory nature of the learning experience. More precisely, what is needed are support strategies which solve the dilemma between a *low-support, low effectiveness, high involvement* and *high-support, high effectiveness, low involvement* situation.

Various authors have investigated the effects of varying levels of instructional support in experiential learning environments. De Jong, de Hoog, de Vries (1993) categorize such support as either directive (for example, hints, Socratic dialogue, corrective feedback) or non-directive (for example, hypothesis sketch pads, goal decomposition trees, overviews of output obtained or input history). Non-directive support is preferred as it maintains the exploratory nature of the learning environment. Shute and Glaser (1990) provided non-directive support in terms of tutoring in scientific skills. Reimann (1991) provided structure for subjects' hypothesis generation and testing through the use of window and notebook facilities to keep track of experiments and to organize and manipulate information, and through the use of graphic and verbal feedback. Njoo and de Jong (1991) studied the effects of providing different levels of support to college level students of engineering using a simulation in the domain of control theory. In addition to providing subjects with notetaking facilities, Quinn and Alessi (1994) showed some success for a strategy of breaking the overall task into subtasks of increasing complexity when used in conjunction with a strategy of generating and testing multiple hypotheses. Quinn & McCune (1995) showed a greater level of exploration on the part of subjects who were successful in completing a variable optimization task than those who were unsuccessful.

Our current focus is on optimizing student learning while promoting and maintaining exploratory behavior in the context of a complex multivariable simulation. The literature on scientific inquiry provides many guidelines to foster hypothesis generation and testing and subsequent exploratory behavior (Popper, 1978; Holland, Holyoak, Nisbett, and Thagard, 1986), with recent research identifying several relevant factors. These include task complexity (Mynatt, Doherty, & Tweney, 1978; Gorman, 1989), effects of working in groups (Gorman, 1989), structure of the phenomenon (Klayman & Ha, 1987), goals (Klayman & Ha, 1987), timing of tests of confirmation and falsification (Mynatt et al, 1978; Tweney, Doherty, Worner, Pliske, Mynatt, Gross, & Arkelin, 1980), familiarity of the context (Cheng & Holyoak, 1985), subjects' prior knowledge (Klahr & Dunbar, 1988), and the number of hypotheses generated (Mynatt et al, 1978; Tweney et al, 1980; Klahr & Dunbar, 1988).

This present study is concerned with the development of non-directive support strategies which take into account two of the factors mentioned above - structure of the phenomenon and the effects of working in groups, and is a follow-up to Quinn & Alessi (1994). In that study, the phenomenon being investigated depended on several variables and the overall task presented to subjects was to investigate the effects of modifying four of these variables. One of the variables behaved in a counterintuitive manner (the optimal value for the goal assigned to subjects was its maximum value, but it appeared to many subjects that the optimal value should be the minimum value) and this was the principal reason for subjects failing to obtain the optimal combination of the four variables. The purpose of this study was to increase the proportion of subjects who obtained the optimal combination of variables by requiring subjects to work in dyads. The rationale behind this approach was that requiring subjects to work in pairs would increase the probability of subjects perceiving the counterintuitive nature of the optimal combination of values, while maintaining the exploratory nature of the task. Thus, requiring subjects to work in pairs was seen as a form of non-directive support. In addition, some subjects were presented with the overall task initially and some subjects were presented with the task in stages. Such a design allowed investigation of task structure on performance. Therefore, the principal research questions in this study were: 1) what will be the effect of subjects' working in pairs on performance on a task involving variables which behave in a counterintuitive manner?; and 2) what is the effect of task structure on such performance?

Methods

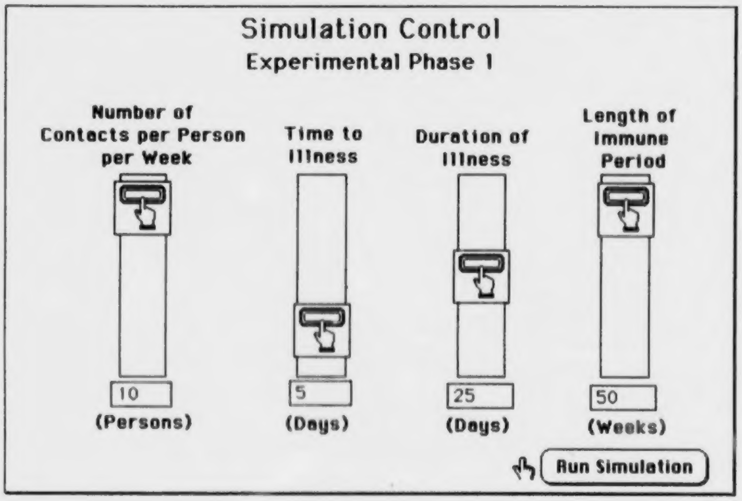
Subjects

Subjects were 66 students in a teacher education program. Twenty-one students were enrolled in a 1 semester hour course titled "Introduction to Microcomputing for Teachers", 30 students were enrolled in a three semester hour course titled "Educational Psychology and Measurement", and the remainder (15) were enrolled in a three semester hour course titled "A Survey of Computer Applications in Instruction". All were given bonus points for participation.

The Simulation

The computer simulation was a model of the spread of an influenza epidemic. There were two displays in the simulation (Figure 1 and 2) and it was very easy to operate. On the control display (Figure 1) the subject dragged sliders to choose values of the 4 variables. The subject then pressed the Run Simulation button to obtain the next display (Figure 2). This display shows both tabular and graphic representation of the number of people ill across time. The subject could then click the Simulation Control button (returning to the control display) to try new values and observe the output, or click the End of Phase 1 button to go on to the next phase of the experiment. Typically, subjects go back and forth between these two displays, changing variables and observing the result, until they believe they have solved the assigned problem. All subjects were presented with the following goal: to determine the combination of variable values that would keep the maximum number of people ill in any one week as low as possible. Subjects were told that they could consider the outbreak to be over as soon as the number of people ill fell below 150 as the outbreak receded.

Figure 1. Simulation control display.



Simulation Control

Experimental Phase 1

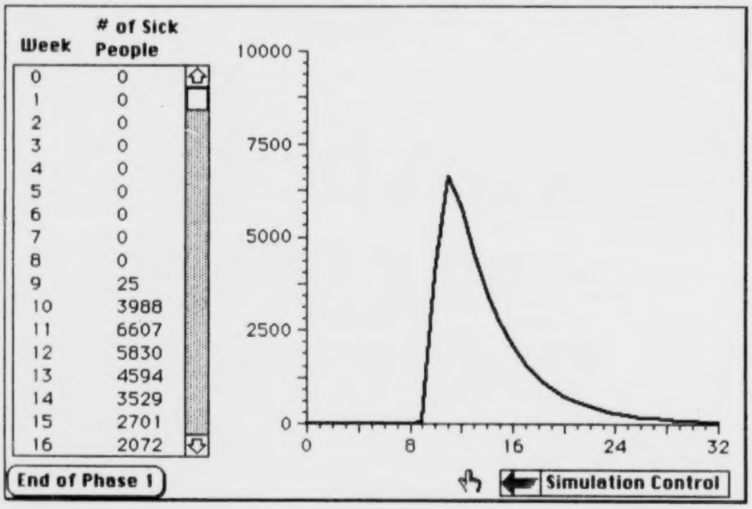
Number of Contacts per Person per Week: 10 (Persons)

Time to Illness: 5 (Days)

Duration of Illness: 25 (Days)

Length of Immune Period: 50 (Weeks)

Figure 2. Graphical and tabular output from simulation.



Week	# of Sick People
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	25
10	3988
11	6607
12	5830
13	4594
14	3529
15	2701
16	2072

In the simulation model, the number of people ill with influenza depended on four variables: the number of contacts per person per week, the time to illness, the duration of illness, and the length of the immune period. The output observed was the rise and decline of infection within a population of 10,000 people over 32 weeks. The range of these variables are presented in Table 1. Table 2 presents the optimal values of these variables for each of the goals presented to subjects. In Quinn & Alessi (1994), the proportion of subjects who reached the correct conclusion for Goal 1 was approximately 70%. In addition, the principal reason for an incorrect conclusion to Goal 1 was an incorrect specification for the optimal value of the variable "Time to Illness" - 50.6% of subjects who failed to complete the task successfully incorrectly specified the minimum value of the variable "Time to Illness" rather than the maximum value.

Table 1.

Ranges and of Variables Affecting Spread of Influenza in the Simulation Model.

Variable	Range
Number of Contacts per Person per Week	2 to 10 persons
Time to Illness	3 to 28 days
Duration of Illness	14 to 35 days
Length of Immune Period	13 to 27 weeks

Table 2.

Optimum Values of Variables Affecting Spread of Influenza in the Simulation Model.

Variable	Optimal values for minimizing maximum number ill in any week.	Optimal values for minimizing the number of weeks the outbreak lasts.
Number of Contacts per Person per Week	2 persons	2 persons
Time to Illness	28 days	2 days
Duration of Illness	14 days	14 days
Length of Immune Period	27 weeks	27 weeks

Design

Subjects were divided into four treatment groups. In each treatment the overall goal was the same and subjects were required to manipulate all four variables. In two groups (I234 and I4) subjects worked on their own and in two groups (G234 and G4) students worked in pairs. All subjects were randomly assigned. In groups I4 and G4, subjects were presented with all four variables initially. In groups I234 and G234, subjects were first presented with two variables and were required to specify the optimal value of these two variables (Phase 1). When subjects concluded they had specified the correct combination of variables, a third variable was introduced and the process was repeated for three variables (Phase 2). Finally, a fourth variable was presented and subjects determined the optimal set of values for all four variables (Phase 3). For each of the four groups, subjects were asked to complete a questionnaire about their interaction with the simulation. The dependent variables measured were the proportion of subjects who reached the correct solution (Correct) and the amount of investigation as measured by number of simulation runs performed by subjects (Simrun).

Procedures

Subjects in groups I4 and I234 (who worked individually) first proceeded through an orientation phase where they were introduced to the subject matter of the simulation and learned how to manipulate the simulation. In this phase, subjects were also given a brief description of the four variables. Subjects were then asked to generate and record an initial hypothesis as to what combination of variables would keep the number of weeks the outbreak lasts as small as possible, while at the same time keeping the maximum number ill in any one week less than 1500. Subjects could specify a range of values for any or all variables and were also given the option of indicating that they did not think that there was any combination of variables which would satisfy the goal. Then, subjects were instructed to begin investigation by manipulating the levels of the variables and running the simulation. Before each run of the simulation, subjects were required to record on an Experimentation Record Sheet the levels of each of the variables in the proposed simulation run. Then, subjects were instructed to begin investigation by manipulating the levels of the variables and running the simulation. After each simulation run, subjects were asked to record the maximum number ill in any one week period and the length of the outbreak. Subjects were not given feedback as to the correctness of the levels chosen. Only by manipulating variables and observing the output from the simulation could subjects increase their confidence that a particular set of values would generate data to fulfill the goals of the simulation.

Subjects in groups G4 and G234 proceeded through the task in a manner similar to subjects in groups I4 and I234 except that additional instructions were given about working together. In the orientation phase, subjects working in pairs were told that they would be working on the task together and were instructed to proceed through the orientation phase working together. At this point, subjects were also told that throughout the study, they could discuss as much as they wish and perform as many simulation runs as they wished. One Experimentation Record Sheet was available to each group. Subjects were told to decide which group member would record data on the record sheet and which member would interact with the simulation. Finally, it was emphasized to subjects that while they would work in groups, it was not necessary that they agree on the optimal combination of values for the specified goal. Each group member recorded their conclusions separately.

Results

Analysis of variance was first performed to determine the effectiveness and efficiency of the two treatments - Learning Context (individual versus group work), and Task Structure (presentation of variables all at once or in parts). This was done by analyzing the dependent variables Correct - proportion of subjects reaching the correct conclusion, and Simrun - the number of simulation runs performed by subjects.

Effectiveness

The dependent variable, Correct, measured the proportion of subjects who came to the correct conclusion. Subjects who came to the correct conclusion were given a score of 1; subjects who did not reach the correct conclusion were given a score of 0. Table 3 presents the mean proportion and standard deviation of students who reached the correct conclusion in the simulation in each group. Analysis of variance indicated a significant Learning Context by Task Structure interaction [F(1,61) = 5.330, MSerror = 1.224, p = .024]. The data are plotted for clarity in Figure 3. In view of the interaction, simple effects were examined at each level of Learning Context. The test for simple effects of Learning Context indicated a significant effect for Learning Context only in the case where all four variables influencing the outcome of the simulation were presented at once [F(1,61) = 20.436, MSerror = 4.694, p = .000]. When all four variables were presented at once, subjects performed better when they worked in a group than when they worked alone. The test for simple effects of Task Structure indicated a significant effect for Task Structure when subjects worked individually [F(1,61) = 38.773, MSerror = .230, p = .000] and in groups [F(1,61) = 8.845, MSerror = .230, p = .004. A significantly greater proportion of subjects who worked individually reached the correct conclusion when the task was presented in parts; in contrast a greater proportion of subjects who worked in groups reached the correct conclusion when the task was presented in its entirety.

Figure 3. Proportion of subjects reaching the correct conclusion by learning context and task structure.

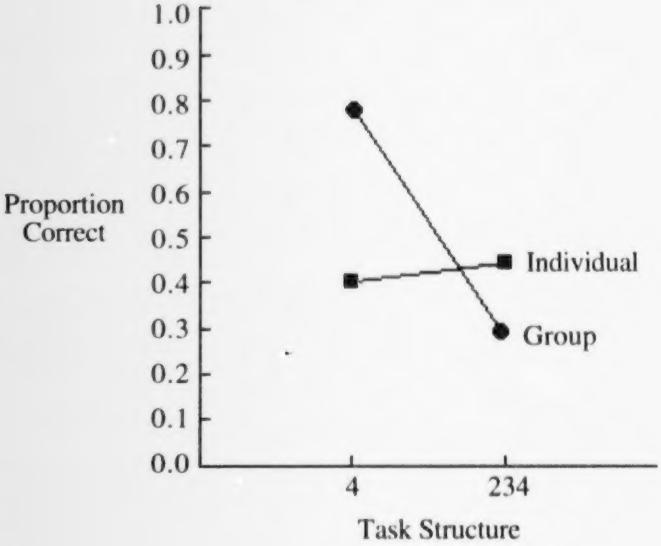


Table 3.

Proportion of Subjects Reaching the Correct Conclusion.

GROUP		Proportion of Subjects Reaching Correct Conclusion
Group I234	M	.444
	SD	.511
		(n=18)
Group G234	M	.278
	SD	.461
		(n=18)
Group I4	M	.400
	SD	.507
		(n=15)
Group G4	M	.786
	SD	.426
		(n=14)

Efficiency

The dependent variable Simrun measured the number of simulation runs performed by each subject. Table 4 presents the means and standard deviations for Simrun only for those subjects who successfully completed the simulation. Analysis of variance did not indicate any significant differences between groups in terms of efficiency.

Table 5 presents the means and standard deviations for Simrun for all groups. Analysis of variance indicated significant main effects for Task Structure [F(1,61) = 12.644, MSerror = 221.880, p = .001]. Subjects performed significantly fewer simulation runs when the task was presented all at once rather than in parts.

Table 4.

Number of Simulation Runs Performed by Subjects Reaching the Correct Conclusion.

GROUP		Number of Simulation Runs Performed by Subjects Reaching the Correct Conclusion
Group I234	M	31.835
	SD	12.722
		(n=8)
Group G234	M	36.800
	SD	21.241
		(n=5)
Group I4	M	30.107
	SD	20.203
		(n=6)
Group G4	M	18.091
	SD	11.077
		(n=11)

Table 5.

Number of Simulation Runs Performed by All Subjects.

GROUP		Number of Simulation Runs Performed by All Subjects
Group I234	M	30.111
	SD	13.248
		(n=18)
Group G234	M	35.444
	SD	16.343
		(n=18)
Group I4	M	20.400
	SD	16.008
		(n=15)
Group G4	M	18.714
	SD	13.652
		(n=14)

Discussion

With regard to learning effectiveness, the interaction effects indicated no clear advantage for either Learning Context or Group Structure alone. Thus, there was no clear advantage for presenting the task in parts or allowing subjects to work with a partner. Rather, the results indicated that the effectiveness of allowing subjects to work with a partner depended on whether all variables were presented at once or in parts. The findings suggest that subjects who worked with a partner performed better when the task was presented all at once than when it was presented in stages. This finding suggests that when a task is complex, individuals may benefit from working with a partner, but when a task is simple there may be no advantage to working with a partner. On the other hand, subjects who worked alone performed better when the task was presented in parts rather than all at once. Thus, our hypothesis that subjects in the group condition would outperform those working individually was not confirmed. In addition, there was no clear advantage for breaking the task into subtasks.

It was not surprising that groups performed better when all variables were presented at once. We might have concluded that the simple task didn't require the extra resources of a group if both the individuals and groups had done very well, but in fact both did rather poorly, especially the groups. This may be due to the fact that presenting the simulation in stages of increasing complexity made it logistically more complicated. Students may have expended a great deal of effort on the first sections and then may not have wanted to devote much of their time or attention to the final stage to reach a correct conclusion. Groups did not make significantly more runs but they may have taken a bit longer per run especially in the simplified presentation. Thus the groups who were presented with the task in parts may have become fatigued toward the end of the simulation.

Another major finding in this study was that subjects who worked individually performed significantly better when the task was presented in parts. One implication of this finding is that when subjects work alone they do not have access to the types of support provided in a group setting, thus they benefit from instructional support built into the instruction. Overall the findings indicate that there are two ways to provide instructional support. First, the task may be divided into more manageable parts or individuals may be allowed to work with a partner; however both of these strategies or types of nondirective support should not be combined. Also, although learning is improved by decomposing a task for individuals working alone, the far more effective strategy is to present the task all at once but to groups rather than to individuals.

In terms of learning efficiency, the results of this study indicated an advantage for presenting the task in its complexity. Subjects performed significantly fewer runs when they were presented with all four variables at once. This finding coupled with the finding regarding learning effectiveness suggests that learning is most effective and efficient when tasks are presented in all their complexity to groups as opposed to individuals. One implication of this result is that attempting to simplify a task by decomposing it into parts may make the task more logistically cumbersome. Another interpretation of this finding is that breaking a complex task into its component parts and making it more cognitively manageable for learners may increase their willingness to persevere on a task.

Conclusion

This study investigated the effects of group versus individual learning and task presentation format on learners' ability to understand and simultaneously consider the effects of more than one variable on a single dependent variable. There appears to be no clear advantage for individual versus group work. The effectiveness of either learning context depends on the complexity of the task at hand. When the task is simple, learning context does not make a difference in performance. However, when the task is complex there is a significant advantage to working in a group. Some of the benefits of working with other individuals on a task are that it encourages one to view phenomena from multiple perspectives, increases level of commitment to solving a task, and also increases the amount of cognitive effort invested in a task because of the subtle social pressure of working in a group (Rysavy & Sales, 1991). Thus, individuals are more likely to reap the benefits of working in groups on complex tasks than on simple tasks, since simple tasks do not require viewing ideas from multiple perspectives, or investing a great amount of cognitive effort, or an inordinate amount of perseverance. The findings of this study suggest that a more effective way of facilitating learning of complex tasks is to have individuals work in groups rather than simplify the task by decomposing it into more manageable pieces. This finding is encouraging in light of the practical concerns of most teachers. Rather than spend time watering down difficult concepts teachers would do better to simply have students work with a partner to solve a difficult task or understand a complex topic. This strategy does not require more time on the part of the teacher and also has numerous other benefits for the student apart from the cognitive advantages, such as the acquisition and practice of social skills, improved self esteem, and the increase in perceived status of low achieving students (Rysavy & Sales, 1991).

Given the increasing emphasis on constructivist software tools such as simulations, it is imperative that educators identify ways to help students manage the cognitive demands of computer-based simulations yet still preserve their exploratory nature. This study suggests that one way to facilitate learning from simulations which present complex tasks is to allow subjects to work in groups. However, this study did not assess comprehension of the material presented in the simulation, thus, one issue that needs to be addressed in future research is comprehension as opposed to simply arriving at the correct conclusion in a simulation or not. Thus, future research should assess comprehension through the use of a posttest given that it is entirely reasonable that subjects may have learned a great deal yet may still not have arrived at the correct conclusion.

A second issue that needs to be addressed in future research concerns the optimal size of groups. At what point do the logistics of additional group members outweigh the pedagogical benefits of collaborative learning in a simulation? Future research should investigate the effects of allowing subjects to work in groups consisting of more than two members.

A third issue for future research concerns the operational definition of task complexity. In this study, task complexity was defined in terms of logistics. That is, the task was simplified by decomposing it into parts as opposed to presenting a different task that was conceptually simpler. It would be of interest to investigate the interaction between task complexity when the task is made simpler conceptually as well as logistically.

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Title:

Perceptions of the ID Process: The Influence of Visual Display

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Background and Rationale

During years of teaching principles of instructional design (ID) to graduate and undergraduate education majors, the authors have noted that, when initially presented with models that use rectangles and straight lines to visualize the process (e.g. Dick & Carey, 1990; Seels & Glasgow, 1990; Smith & Ragan, 1993), students' first impression of the ID process is that it is rigid, inflexible, fixed, and perhaps not very relevant for use in a real-world K-12 classroom. However, when students have first been introduced to Kemp's circular model (Kemp, 1985; Kemp et al., 1994), students' initial perceptions of the ID process are that the process is somewhat flexible and adaptive and may be beneficial to them as teachers. Kemp himself indicates (Kemp, 1985, p. 12; Kemp et al., 1994, p. 10) that his choice of a circular model was chosen to visually emphasize the flexibility of his approach to instructional design.

From the perspective of visual communication, vertical and horizontal lines, squares, and blocks are associated with feelings of stability and stasis while circular forms and curved lines imply movement, motion, and dynamism (Dondis, 1973; Heinich, Molenda, & Russell, 1993). If, when working to encourage teachers to use an instructional design model as a flexible framework for designing good instruction and not as a lock-step, rigid format to be followed without integrating one's own professional expertise, then the manner in which an instructional design model is visually depicted becomes an important instructional consideration. Students' perceptions of the instructional design process itself may be heavily influenced by the way in which ID models are visually depicted.

In thinking about students' potential perceptions of both the process of instructional design and the models used to visualize it, the authors identified three factors of primary interest: flexibility, organization, and value. Flexibility, used in the context of this study, is the characteristic of the ID process or model that indicates the degree to which it is responsive to being adapted or changed. Organization, as defined by the authors, is the characteristic of the ID process or model that indicates the manner of relationship among the process/model elements, the overall structure and pattern of the process/model, and the logic, meaning, and clarity of that pattern. Value is the characteristic of the ID process or model that indicates the degree of usefulness or importance.

This is the seminal investigation in a planned series of investigations and, as such, the major goal was to determine if the way in which the instructional design process is visually depicted by a two-dimensional model influences preservice teacher perceptions of the flexibility, organization, and value of the ID process itself.

Research Questions

As indicated above, this study was designed to investigate the influence of the visual display of an instructional design model on preservice teachers' perceptions of the instructional design process. The overall research hypotheses included the following:

1. Providing preservice teachers with information about the instructional design process will increase their perceptions of the flexibility, organization, and value of the process.
2. Preservice teachers will perceive the ID process to be more flexible when a curved/oval model is used to visually represent the process than when a straight/rectangle model is used.
3. Preservice teachers will perceive the ID process to be no more or no less organized when a curved/oval model is used to visually represent the process than when a straight/rectangle model is used.
4. Preservice teachers will perceive the ID process to be more valuable when a curved/oval model is used to visually represent the process than when a straight/rectangle model is used.
5. Prior experience with ID, prior experience teaching, anticipated teaching level or content, year in college, and gender will have no effect upon preservice teachers' perceptions of the flexibility, organization, or value of the ID process as visually depicted by either curved/oval or straight/rectangle models.

Additionally, the authors were interested in assessing preservice teachers' general reactions to the instructional design process. Study participants were asked to respond to the following:

6. List any other words to describe how you feel about the instructional design process.
7. Which model do you think best represents what happens in the instructional design process?
8. If you were going to teach some of the principles of the instructional design process to someone else who was planning to be a teacher, which model would you show to the other person as you explained the instructional design process?

Methodology

This study was conducted during the Fall 1995 semester following a pilot study that occurred during the Spring 1995 term. In both cases, the sample consisted of undergraduate education majors enrolled in an introductory education class at a four-year university in the Rocky Mountain west.

Word Pairs:
Flexibility Characteristic

structured-------unstructured
inflexible-------------flexible
rigid-----------------adaptable
firm-----------------malleable
regulated------------sporadic
unyielding----------yielding
exacting ---------modifiable
fixed------------------pliable
constant -----------changing

Figure 1. Flexibility antonym pairs

The students were first assessed on their initial knowledge and perceptions of the ID process. The assessment included a self-report of demographic and experiential characteristics including prior experience with instructional design ("none" or "some") and a 26-item, 5-point Likert-type scale on which students indicated the degree to which they felt one or the other of a particular set of antonyms described their feelings about the ID process (See Figures 1, 2, and 3). These antonym sets were categorized into three characteristic areas: flexibility, organization, and value/usefulness. Students were then given a three hour introduction to instructional design as part of a standard curriculum. During this period of direct oral instruction over the material, students received a printed outline of the "steps" in the Smith-Ragan (1993) ID model but no visual representation of the model. After instruction, students' perceptions of the ID process again were assessed using the 26-item Likert-type scale. After this posttest, students viewed first one and then the second of two visual depictions of the Smith-Ragan ID model. One model was drawn with curved lines and ovals and the other original model was formed with straight lines and rectangles. The layout, size, font styles, and other visual elements remained constant between the two models (See Figures 4 and 5).

Word Pairs:
Organization Characteristic

linear----------------circular
abstract------------concrete
random----------sequential
inconsistent-----consistent
informal-------------formal
irrational-----------rational
misleading------------clear
complicated---------simple
disorganized----organized
unplanned---------planned
haphazard-----methodical
disorderly----------orderly

Figure 2. Organization antonym pairs

Word Pairs:
Value Characteristic

unhelpful---------helpful
difficult--------------easy
confusing---------logical
foolish-----------sensible
worthless-------valuable

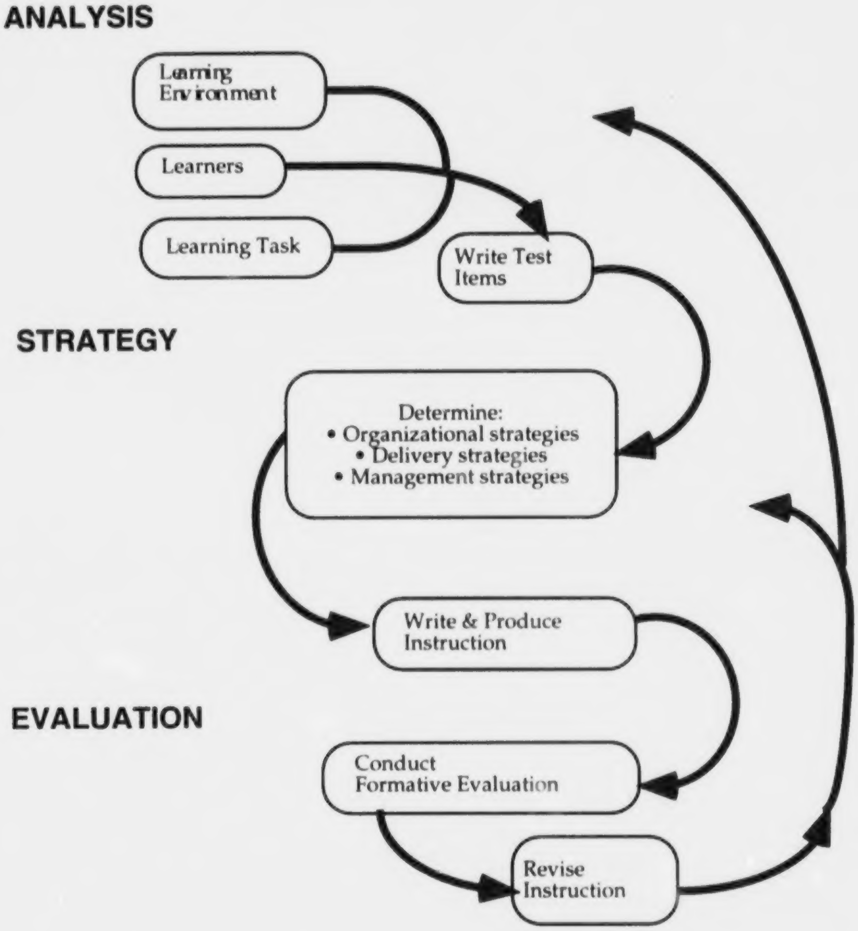
Figure 3. Value antonym pairs

During the study, half of the students were given the curved/oval model first and then completed the 26-item assessment and one question probing for any other words they associated with instructional design process. The students then viewed the straight/rectangle model and answered the same 26 response items and follow-up question while referring to the second visual. The remaining half of the students were presented with the visual models in the reverse order. After viewing both models, all students were ask to specify which model (curved or straight) best represented what "happens" in the instructional design process and which of the two models they would use if they were teaching the ID process to someone else who was planning to be a teacher.

Thirty-six (36) students participated, of which 24 (67%) were female and 12 (33%) were male. As a group, participants had completed an average of 13.92 years of schooling and represented a wide range of teaching levels and content areas. Fourteen students (39%) had taught in some capacity before, whether in a traditional classroom or as an aide, coach, community service volunteer, or religious education instructor. None had any experience with the instructional design process.

INSTRUCTIONAL DESIGN PROCESS*

Model A

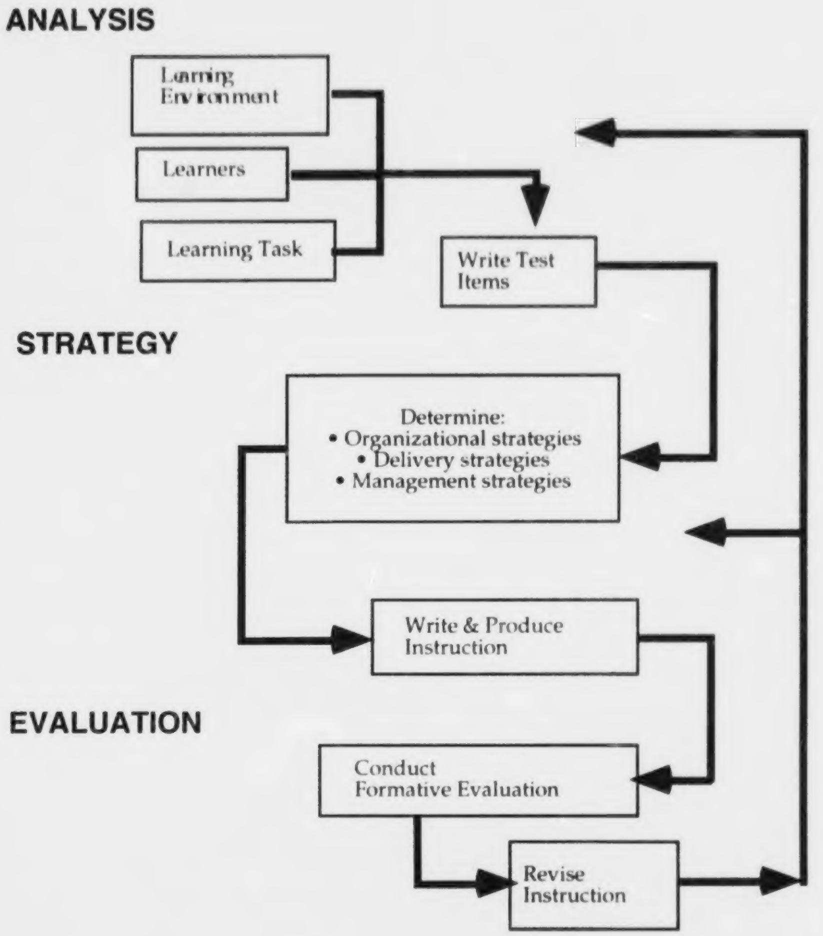

ANALYSIS
Learning Environment
Learners
Learning Task
Write Test Items
STRATEGY
Determine:
• Organizational strategies
• Delivery strategies
• Management strategies
Write & Produce Instruction
EVALUATION
Conduct Formative Evaluation
Revise Instruction

*Adapted from Smith, P. L. & Ragan, T. J. (1993) *Instuctional Design*. New York: Merrill

Figure 4. Curved/oval ID model

INSTRUCTIONAL DESIGN PROCESS*

Model B


ANALYSIS
Learning Environment
Learners
Learning Task
Write Test Items
STRATEGY
Determine:
• Organizational strategies
• Delivery strategies
• Management strategies
Write & Produce Instruction
EVALUATION
Conduct Formative Evaluation
Revise Instruction

*Adapted from Smith, P. L. & Ragan, T. J. (1993) *Instuctional Design*. New York: Merrill

Figure 5. Straight/rectangle ID model

Results

The first four research questions were examined using a paired two-sample for means t-test to indicate any change in response before and after instruction and also before and after viewing of the ID models. This test was significant at the .05 level for Question One. Data suggest that preservice teachers did show a change in their responses between the pretest and the posttest assessing their perceptions of the flexibility, organization and value of the instructional design process, though current data do not yet suggest where these changes occurred. On the posttest, respondents were highly consistent in choosing the terms *sensible* and *valuable* to describe the ID process. Both terms had means in excess of 4.5 on a 1 to 5 scale with the higher numeric values being associated with those two terms. Questions 2 through 4, assessing the flexibility, organization, and value of each of the two models, had varied results. Respondents found the curved/oval model to be significantly more flexible at the .05 level when it was the second model they viewed. No significant preference existed when the curved/oval model was viewed first. Participants perceived the straight/rectangle model to be more organized (significant at the .05 level) regardless of viewing order. No significant difference in the models was found regarding value/usefulness.

In regard to Question 5, the demographic and experiential characteristics selected did not satistically influence responses to any of the questions posed. Analysis of open-ended reponses also revealed no patterns or trends related to the selected demographic or experiential charateristics.

In analyzing the open-ended responses to Questions 6 through 8, interesting patterns emerged. Student responses to Question 6 are summarized in Figure 6.

Model Viewed

○	□
• Good framework	• Easier to comprehend
• Worthwhile process	• Smooth
• Orderly	• Confusing
• Very prepared	• Easier to follow
• Cyclical effect	• Constant learning process
• Learning	• Adaptable, but structured
• Out of order	• Time consuming, but valuable
• Overwhelming	• Strict
• Too many paths	•Straightforward
• Confusing	• Arranged
• Lost running in circles	• Structured
• Cognitive flow chart	• Square
• Too concrete for my thinking style	• Orderly
• Overwhelmed	• Direct approach
• Difficult to follow	• Learning
• Chaotic	• Revise
• Confusing	• Flows smoothly
• Looks complex, but isn't	• Organized
• Organized, but adaptable	• Visually clear
• Not enough flexibility	• Understandable
•Time consuming, but valuable	

Figure 6. Words generated to describe the ID process

Though data were summarized in a manner to observe any influence caused by the order in which the students viewed the models, presentation order does not appear to influence these responses. Student-generated words used to describe the instructional design process as depicted in the curved/oval model included the terms orderly, confusing, smooth, overwhelming, adaptable but structured, time consuming but valuable, out of order, easier to comprehend, and easier to follow. Quite similarly, student-generated words used to describe the instructional design process as depicted in the straight/rectangle model included the terms orderly, confusing, flows smoothly, overwhelmed, organized but adaptable, time consuming but valuable, chaotic, understandable, and straightforward. Overall, the very same words or those with similar meanings were used to describe both the positive and negative aspects of the instructional design process regardless of whether curved or straight lines were used to visually depict the model. These descriptive words were not necessarily provided by the same students.

In considering Question 7, Figure 7 depicts the number of students who indicated a preference for the curved/oval, the straight/rectangle, or neither model as the best representation of what occurs during the instructional design process. Descriptive statistics indicate that, of the 36 preservice teachers, 13 students (36%) believed that the curved/oval model best represented the ID process, 14 students (39%) believed that a straight/ rectangular models best did so, and 9 students (25%) believed neither model was better.

	Model Viewed First	
Model Selected	○	□
○	9	11
□	4	3
Neither	5	4

Figure 7. Number of students selecting each model as "best"

When the curved/oval model was viewed first by 18 students, 9 students (50%) indicated that it was the best representation of the ID process, 4 students (22%) indicated that the straight/rectangle model was the best, and 5 students (28%) indicated neither was better. When the straight/rectangle model was viewed first by 18 students, 11 students (61%) indicated that the curved/oval model was the best, 3 students (17%) indicated that the straight/rectangle model was best, and 4 students (22%) indicated that neither was better. Overall, 20 students (56%) indicated that the curved/oval model was the best representation of what happens in the instructional design process, 7 students (19%) indicated that the straight/rectangular model was the best, and 9 (25%) students responded that neither model was a better representation of the ID process.

Data relating to Question 8 above are presented in Figure 8. In a similar manner to the data collected for Question 7, descriptive statistics indicate that of the 36 preservice teachers, 14 students (39%) believed that they would use the curved/oval model to teach the ID process, 13 students (36%) believed that they would use the straight/rectangle model to do so, and 9 students (25%) had no preference for use. When the curved/oval model was viewed first by 18 students, 9 students (50%) indicated that it was the model they would use to teach the ID process, 5 students (28%) indicated that they would use the straight/ rectangle model, and 4 students (22%) responded that they had no preference for use. When the straight/rectangle model was viewed first by 18 students, 11 students (61%) indicated that the curved/oval model was the one they would use to teach, 2 students (11%) indicated that the straight/rectangle model was the one they would use, and 5 students (28%) indicated that they had no preference for use.

	Model Viewed First	
Model Selected	○	□
○	9	11
□	5	2
Neither	4	5

Figure 8. Number of students selecting each model as "choice to use to teach"

With overall data strikingly similar to that of Question 7, 20 students (56%) indicated that the curved/oval model was the model they would use to teach instructional design process, 7 students (19%) indicated that the straight/rectangular model was their choice, and 9 (25%) students responded that they did not have a preference of model to use to teach the ID process to a colleague. Additional data indicate that, though students strongly tended to select the same model as the "best" one and their "choice to use to teach," this was not always the case.

Data displayed in Figures 9 and 10 also provide insight into the students' perceptions of the "best" and "choose to use to teach" models as they provide verbal explanations of their decisions. Again, the order of presentation did not appear to affect the terms chosen to describe student reasoning behind their preferences. As depicted in Figure 9, regardless of whether it was presented first or second, if the curved/oval model was preferred, the most common reasons included that it was more flexible, more modifiable, and more adaptable. Regardless of whether the straight/rectangle model was viewed first or second, it was described as more organized, easier to follow, and easier to understand. No comments were made if students did not perceive one model as better than the other. In a similar manner, results displayed in Figure 10 indicate that the order of presentation did not appear to affect students' choice of words generated to describe their preference of one model or the other that they would chose to use when teaching someone about ID. Whether presented first or second, the curved/oval model was generally perceived as malleable, not as fixed, more flexible, easier to understand, and more flowing. Again regardless of presentation order, the straight/rectangle model was perceived as more organized, more clear, more structured, easier to understand, and easier to follow. Students who selected no model preference indicated that they would integrate the use of both models but did not supply additional words to describe the models.

Model Viewed First

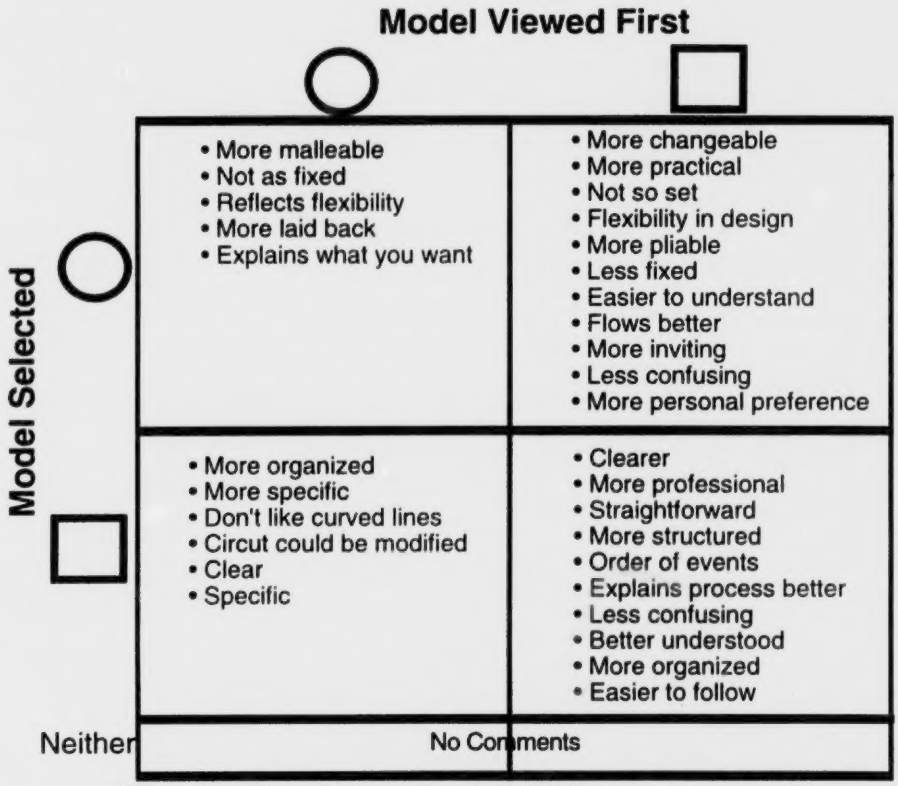
Model Selected	○	□
○	• More flexible • Easy to modify • Not as fixed • Not so strict • More like a tool • Not set in stone • Not so confusing	• More circular—how I see the process • Easier to follow • Flowed smoothly • Flexibility in design • More pliable instead of fixed • More modifiable • More adaptable • More flexible
□	• More straightforward • More organization • More direct • Easier to understand • Easier to follow • More structured • Easier to visualize what happens •More easily changed & manipulated • More logical	• More like circuits in electricity • More organized • Don't like curved lines • More specific
Neither	No Comments	

Figure 9. Reasons underlying preference for "best" model

Discussion and Recommendations

Regarding Question 1, data indicate that preservice teachers changed their responses between the pretest and posttest assessing their perceptions of the flexibility, organization, and value of the ID process. Students' perceived the ID process as more flexible, more organized, and more valuable/useful after the instructional intervention. Student indications that ID was perceived as *sensible* and *valuable* comfort the researchers, who believe that the ID process indeed is worthwhile to teach to these preservice teachers.

Questions 2, 3, and 4 may be affected by the order in which students viewed the model, but evidence that they perceived the straight/rectangle model to be more organized was highly significant (.01 level). Students who viewed the curved/oval model second responded significantly (.05 level) that it was the more flexible model. This perception of greater flexibility is also supported by responses to the open-ended questions. Conversations with Jerrold Kemp (personal communication, February 17, 1996) provide additional insight into this observation. Kemp suggests that straight/rectangle models may provide novice instructional designers with valuable structure and organization while more mature instructional designers appreciate the flexibility represented in curved/oval models. This is an avenue for further investigation.



	Model Viewed First	
Model Selected	○	□
○	• More malleable • Not as fixed • Reflects flexibility • More laid back • Explains what you want	• More changeable • More practical • Not so set • Flexibility in design • More pliable • Less fixed • Easier to understand • Flows better • More inviting • Less confusing • More personal preference
□	• More organized • More specific • Don't like curved lines • Circut could be modified • Clear • Specific	• Clearer • More professional • Straightforward • More structured • Order of events • Explains process better • Less confusing • Better understood • More organized • Easier to follow
Neither	No Comments	

Figure 9. Reasons underlying preference for "choice to use to teach" model

In considering Question 5, open-ended responses indicate that the demographic and experiential characteristics of the students that were selected for this study may not be as influential in determining student preferences as other factors not yet investigated. Among some of the additional characteristics possibly influencing preservice teachers' perception of the ID process itself and the way in which it is visually depicted include individual learning style preferences; cognitive style factors such as locus of control and field dependence/independence; educational background such as electrical engineering training or experience in reading other types of flowcharts; individual preference for structure or flexibility; and personal visual appeal. In conjunction with data collected to address Question 6, this observation is supported by the similarity between the words students consistently generated to describe both the curved/oval model and the straight/rectangle model and the ID process itself. Apparently, student characteristics other than those identified have a greater impact on their perceptions of the ID process and the visual representation of the model, and this is an area for continued investigation.

With regard to Questions 7 and 8, a majority of students (56% in each case) indicated a preference for the curved/oval model as the "best model to represent the ID process" and as the "choice of model to use to teach the ID process." However, data do not indicate why this preference exists, particularly when a statistically significant number of students indicated that the straight/rectangle model was more organized. This is another area in which further investigation is being conducted.

The importance of the visual display of ID models for professionals teaching the instructional design process is summarized by two very different quotations from two sophomore students, both of whom had no preference for a "best" or "choice to use to teach" model. One student lamented: "I understand the presentation that you gave and it was very helpful . . . but I don't get these dang models!" This comment underscores the importance of presenting a visual representation of the ID process that facilitates—not hinders—students' acquisition of the principles underlying the instructional design process. Numerous comments also could be cited to support the observation of students' preferences of models based on their own personal preferences for structure or flexibility. However, one very astute student concluded: "The only difference is the lines as far as I could see. To me lines that are curved or lines that are straight still point to the same thing. . . . Curved lines may indicate flexibility & straight lines more structure & less variance. I look at the design as both flexible & structured." Since this is one of the key messages regarding the instructional design process that the researchers attempt to convey to preservice teachers, perhaps preservice teachers should be introduced to both curved/oval and straight/rectangle visualizations of the ID process. This study has generated more questions than it has answered, and the question of the impact and importance of the visual display of an ID model on student perceptions of the process itself remains a viable area for additional research.

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Title:

Robert M. Gagne's Impact on Instructional Design Theory and Practice of the Future

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Instructional Technology is a field that has grown from two separate knowledge bases and two related areas of practical concern. While its original roots were in the study and construction of visual aids as teaching devices, the second major line of intellectual heritage emanated from instructional psychology, and provides the bases for many principles of instructional design theory and practice. Gagne has been a central figure in this infusion of psychology into the field, and indeed in the "creation" of the domain of instructional design. Today, the bulk of the research and theory in Instructional Technology is concentrated in the design domain with less research emphasis place upon utilization, management, evaluation, and even the important domain of development (Seels & Richey, 1994).

Instructional design can be seen in terms of either macro-design procedures which provide overall direction to a design project (typically using instructional systems design principles) or micro-design that involves the design of lessons and instructional strategies which constitute those lessons. Gagne's contributions have been primarily in the development of micro-design principles and procedures.

Gagne's orientation to design now serves as the crux of most micro-design models, such as in Instructional Transaction Theory (Merrill, Li, & Jones, 1991), Elaboration Theory (Reigeluth and Stein, 1983), or the ARCS Model of Motivation Design (Keller, 1987). In each of these models, learning is fundamentally viewed as an internal process that is:

- dependent upon past learning; and
- stimulated and controlled by external events;
- expedited by instruction which varies depending upon the nature of the desired outcome; and
- precipitated by the use of sequenced instructional strategies that provide motivation, direction, guided practice, feedback, and reinforcement.

These ideas emanate substantially from the work of Robert Gagne.

The principles promoted by Gagne provide not only a theoretical orientation to an instructional design project, but also have prompted a number of design conventions and techniques. His ideas are now reflected in a variety of work environments, including corporate training, the military, the health care industry, as well as educational settings. In addition, his design principles have been integrated into delivery systems of all types.

The key question to be examined in this paper, however, is "To what extent will Gagne's theories *continue* to influence the field as design research expands and as design practice changes in response to new demands and pressures?". While Gagne's dominance has been assumed in the past, this question is not unrealistic in the current climate of growing alternative perspectives of both research and design processes. Today's intellectual climate is subject to many pressures from new theoretical orientations, as well as from on-the-job demands for additional efficiency and effectiveness. These changing pressures and ideological influences may also control the impact of the Gagne design orientation.

Nonetheless, Gagne's influence has been so pervasive that it is easy to find traces of Gagne theory even in the most divergent design orientations. The aim of this paper is not so much to further identify Gagne's imprint on our field in *emerging* design theory and practice, but rather to analyze these trends in an effort to predict the stability and continuing relevance of his theory.

The Continuing Domination of Gagne Doctrines in Design Theory

Previously unvoiced challenges to traditional principles of instructional design theory are now surfacing in the field. To a great extent, these challenges stem from criticism of our heavy reliance upon general systems theory and conventional learning theory. New learning and instructional theory, especially those positions concerning the role of the learning task, the impact of the learner and learner control, and increased concern with the need for transfer of training, is closely related to Gagne's work. These innovations are presented within the context of constructivism, situated learning, and an even more pronounced emphasis on cognitive psychology principles. As a whole, they raise the possibility of fairly profound changes in design practice.

The Emerging Tension Between Learner-Oriented and Content-Oriented Instruction

Trends in Learner-Centered Instruction. Instructional design procedures are guided by both the nature of the learning task and the nature of the learner. With respect to the learning task, Gagne's work leads to an analysis of the content so that one can not only determine the sequence of a lesson, but also diagnose the prerequisite skills of the learner (Gagne, 1962, 1968a; 1968b). Instructional strategies are also contingent upon the learning task, since they vary depending upon the type of task being addressed. For example, problem solving tasks are taught differently from concept formation tasks. While learner characteristics are clearly important, traditionally instructional design procedures have been controlled more by the *material* to be taught than by the *persons* receiving the instruction. This position is totally compatible with the objectives-oriented stance of instructional systems design models. However, to many it is also an outdated vestige of behavioral learning theory.

Currently, there are trends toward a change in this stance with much of the new theoretical thinking focusing more centrally on the learner, with content taking a somewhat secondary role (Richey, 1993). This is most evident in constructivist theory that posits that meaning and reality are functions of individual interpretation (Jonassen, 1991; Lebow, 1993), and learning itself is a process ...

> ... in which the learner is building an internal representation of knowledge. ... This representation is constantly open to change, its structure and linkages forming the foundation to which other knowledge structures are appended. Learning is an active process in which meaning is developed on the basis of experience (Bednar, Cunningham, Duffy, & Perry, 1992, p. 21).

Central to constructivism in its most extreme form is the rejection of the notion of an objective reality and the role of external events (i.e., external conditions of learning) as ways of promoting a common reality for a group of people (Jonassen, 1991). In other words, the emphasis on an individual's internal processing of information is completely dominant. The learner and learning processes control, and even shape, the learning task.

In spite of the growing popularity of constructivist principles, many designers are uncomfortable with extreme constructivist positions. Dick's (1992) comments in this regard are noteworthy. He observes that educational interventions that are truly constructivist must necessarily provide the learner with almost total control of the instructional process, *including* the selection of objectives and learning activities. This is less because of an adherence to laissez-faire philosophy than it is to a belief that pre-designed instruction is meaningless since two individuals will seldom have the same interpretation or understanding of a particular event. This position minimizes the role of structured instructional activities, in favor of a more tutorial model of instructional facilitation. Merrill (1992) also argues against extreme constructivism by pointing out that while learners develop their own internal mental models in most instructional situations, they nonetheless do respond to and interact with abstractions and mental models of others. There is a functional, objective core of knowledge that can easily co-exist with individual interpretations and opinions of the knowledge.

Questions regarding the dominance of content are not confined, however, to constructivists. Many involved in design and development of instruction using the new and emerging technologies have also come to question traditional practice. Hannafin (1992) argues that traditional instructional design theory and models are most effective with "highly prescribed, objective outcomes and the organization of to-be-learned *lesson content*, not the largely unique and individual organization of *knowledge*" (p. 50). Instruction controlled by these pre-defined objectives then tends to be seen as only the transmission of knowledge, rather than the facilitation of learning. Kember and Murphy (1990) voice concerns that the product of such instruction is only surface, rather than deep learning. It is learning that is less likely to be transferred and used by the learner in new situations.

It is predictable that constructivists and technology developers would find common ground in these arguments. The new technologies can facilitate levels of learner control previously unattainable. The technologies can give learners instant access to information, and the ability to link information. The technologies allow totally adaptable, interactive, and less structured designs and learning environments than were typical using traditional design orientations (Hannafin, 1992). Here the content becomes *part* of the learning environment, but the learner is more dominant.

Learner-Centered Design and Gagne. The learner-centered advocates, even those who espouse a more extreme position, do not have theoretical bases that are totally incompatible with Gagne's theory. He stresses the importance of prior knowledge and experience, self-regulated learning strategies, and learner motivation. However, there is a different perspective in the Gagne orientation. While Gagne uses learner characteristics as one basis of strategy selection, the pertinent learner considerations tend to relate to the cognitive processing of information -- the nature and capacity of the learner's memory storage and processing skills, qualities that affect sensory perception, and attitudes that directly impinge on learning. These are factors which shape one's ability and motivation to achieve a given type of learning outcome. They define the learners' cognitive capabilities, prerequisite content knowledge, and interest in a particular topic, and become central to the design of those external conditions that promote learning. Learner characteristics, however, are critical to Gagne's theory primarily in the extent to which they are related to *pre-defined* learning objectives.

Learner involvement (as opposed to learner control) is also a critical aspect of Gagne's work, but learners' participation in the instructional process entails more than simply being engaged in a series of activities, the external performance aspect of instruction. Participation and activity also refer to internal involvement in the perception, storage, and retrieval of information. This is the core of Gagne's cognitive orientation, and the Events of Instruction are designed to promote internal, as well as external activities.

Current advocates of learner-centered instruction present arguments that are multi-faceted, including debates on at least two aspects of the problem:

- who controls the instructional process, and what is the nature of such control? and
- which learner characteristics influence the selection and design of instructional strategies and how they should be addressed?

With respect to the first question, Gagne seems to suggest that the designer (or the instructor) has fundamental control of *instructional* processes that are external events, even though individuals always control their own *learning* processes which are internal events. Superior design of instruction can facilitate learning efficiency, instructional effectiveness, transfer of training, and interest. In these respects then, the designer also exercises a certain amount of control by structuring the external conditions according to research-based principles in a manner that will facilitate internal learning and information processing. Control of the teaching/learning process then is shared by learners and designer/instructors.

Although seldom framed in these terms, the issues surrounding control of instruction seem to have much to do with the type and extent of individualization that is desirable in a teaching/learning environment. Individualized instruction has always been valued by instructional technologists, in spite of the many interpretations of the term. Fundamentally, individualized instruction involves varying the teaching/learning procedures for each student. These variations occur by making different instructional decisions for different students. These decisions include:

- what and how much should one learn?
- when and where should one learn?
- what resources should one use to learn?
- how does one know when learning has occurred or when it has not?

The extent of individualization depends upon the number of decisions made for individuals as opposed for the class as a whole, and the extent to which learners assume control of the decisions regarding their own instruction. For example, an individualized setting may only involve self-pacing of instruction by the students with the content, materials, and testing procedures prescribed by the instructor. On the other hand, a program may be totally individualized with learners making all of their own decisions, and instructors serving as facilitators. Technologically-based delivery systems clearly expedite learner control. For example, most hypertext environments at the least allow students to control content selection, sequencing, and pacing.

Constructivists and many of those involved in using the new technologies to their fullest advantage, tend to advocate more total individualization. Such instruction is not necessarily incompatible with Gagne's principles of learning. Moreover, the compatibility is not dependent upon whether there is a structured or flexible approach to the management of its delivery. Learners can assume a major part of the control of the instruction, and the process can still be perfectly consistent with Gagne's theory. The critical factor seems to be whether the design of this instruction has been grounded in an analysis of the subject matter and the learner prerequisites, not on whether students are involved in collaborative, active learning of highly relevant content.

In some respects, the second aspect of the learner-centered issue is more interesting -- the most critical learner characteristics. Instructional design rooted in a content emphasis, as opposed to a learner emphasis, tends to highlight learner traits that are related in some way to the subject matter of the lesson, including:

- prerequisite skills;
- background experiences which enhance prerequisites and/or interest in the topic of the lesson; or
- the learner's proficiency in those cognitive strategies required to master the content.

Designers are now considering other learner characteristics as well. For example, Richey (1992) has shown the direct impact on learning of other learner characteristics that are not content-related. With respect to adult learning in employee training environments, pertinent factors include learner attitudes toward the instructional delivery system and the organization delivering the training, the previous training experiences of learners, and their work experience. These learner attitudes and background experiences seem to predict not only the extent to which objectives are achieved during training, but also the extent of transfer. Other characteristics currently being studied include feminist thinking (Gilligan, 1982; Canada & Brusca, 1991) and other aspects of a person's cultural background.

It is possible for one to argue that these characteristics shape the cognitive strategies that a learner uses to address a particular piece of instructional content and, as such, are still within the Gagne tradition. Nonetheless, they do represent a line of thinking which, even though logically connected to Gagne's previous work, is suggesting new design procedures and emphases. It is one, however, which is consistent with Gagne's past thinking.

The Emerging Role of Context in Instructional Design Theory

Trends in Context-Centered Instruction. Another area of current theoretical expansion concerns the impact of context upon the teaching/learning process. Of interest, is not only the immediate teaching context, but also the pre-instructional and post-instructional environments in which learners live and work (Richey, 1993; Richey & Tessmer, 1995).

This trend of looking to contextual variables as predictors of learning effectiveness has emerged with the concurrent influence of performance technology, the quality movement, situated learning, systemic design, and once again, constructivism. The commonalty among these divergent theories and movements is an interest in "meaningful" instruction, meaningful to the learner and meaningful to the society that expects to be improved as a result of an educated populace. In the past, such "meaning" has had important implications for the transfer of training from educational environments to real-life behavior. Today, it also has implications for organizational development and quality improvement.

Most instructional design procedures and principles are typically seen as being applicable to all settings. In spite of this, new instructional systems design procedural models are frequently developed in an effort to respond to the seemingly unique aspects of a given situation. This emphasis on situation-specific procedures is complemented by the ever increasing demands that education and training programs serve as quality improvement vehicles and solve specific organizational problems. Contextualization also reflects efforts to create motivating, relevant instruction. While this latter goal is not new, the pressures for intrinsically relevant instruction are increasing with the new emphases on adult education and training and the expectations of children and adolescents reared on action-oriented television. Finally, these events coincide with situated learning and constructivist emphases on "anchoring" instructional activities into meaningful contexts as a means for promoting long-term retention, understanding, and transfer of training. The issue is then an outgrowth of societal changes, as well as new theoretical biases.

The emphasis on context and environment is not unrelated to the learner-centered design thrust, since context is typically a matter of perceptions made by learners in light of their background experiences. Moreover, context emphases also tend to expand the number of factors addressed by designers, sometimes at the expense of instructional content considerations.

Contextualization is typically achieved not only through the topics of instruction, but also through the selection of examples and the nature of the practice exercises. Topics can be those that are currently issues in a particular setting. Examples can be drawn from the social or work culture of the students. Practice can be provided using what Brown, Collins, & Duguid (1989) would call authentic activities. Authenticism involves "ordinary practices of the culture" (p. 34), as opposed to hybrid activities that are more reflective of the education and training culture rather than the "real world". Decontextualized environments, therefore, are not only created through the use of verbal abstractions, but also through the use of examples and practice activities that are not reflective of the daily situations encountered by the learners. One can also create context-rich instruction by using problems, examples, and practice activities involving *multiple* contexts. In this way, instruction seems realistic, even though it is not "anchored" in a given context. This is not the typical approach, however, in many of the newer approaches to context in instruction.

Current emphases on context have the potential of changing design procedures by not only expanding the needs assessment, evaluation, and systems maintenance phases, but also by altering the nature of the instructional strategies themselves. The ultimate goal is instruction that is less abstract, more applied, and more responsive to external realities than had previously been the case.

Context-Centered Design and Gagne. Streibel (1991) summarizes the fundamental difference, in his opinion, between Gagne's theory of instruction and that of situated learning with respect to contextual issues. He sees environmental factors in the Gagne tradition as playing the role of triggering stimuli in a teaching/learning situation, rather than serving as *causes* of behavior. While this characterization may be debatable, the point is well made that context is not as central in the Gagne theory as it is in many current orientations, and the question at hand involves the extent of this deviation. This issue can be analyzed in terms of the implications of context for transfer of training as well as long-term retention -- elements that are not unrelated and need to be considered together.

Transfer of training, from Gagne's perspective, is a function of the extent to which a learner has:

- the required prerequisite knowledge and skills;
- the ability to recall prior learning; and
- developed those cognitive strategies appropriate for the task.

The first is a function of content and background, rather than contextual elements of the instruction. The latter two elements, however, are impacted by context. The ability to recall needed prior learning is a function, in part, of whether the material to be recalled was originally presented within a meaningful contextual framework. If so, it is far easier to recall. Moreover, the contextual anchoring of past instruction in a variety of novel problem-solving tasks not only enhances meaning, but also develops cognitive strategies used in problem solving and transfer of training. Gagne, therefore, tends to advocate context-rich instruction by systematically using alternative contexts for practice, rather than emphasizing the dimensions of only one environment.

What is more likely to strengthen transfer, generalization or context-embedded instruction? Clark and Voogel (1985) conclude that "the extent of transfer is determined, in part, by the amount of decontextualization achieved during instruction" (p. 119), but that the issue is also dependent upon the nature of the learning task and the type of transfer anticipated. Procedural knowledge is more conducive to near transfer (i.e. transfer of skills to situations which are similar to those in which the instruction occurred), while concepts and principles are more appropriate for far, or more generalized, transfer situations. Moreover, Clark and Voogel (1985) assert that the two types of transfer are *not* compatible; one is typically emphasized at the expense of the other, even though all transfer is highly dependent upon learner abilities. In this vein, Gagne would likely assert that even though putting instruction into a meaningful context is important, instruction that is dominated by examples from real-life situations is not necessarily in the best position to promote the process of *far* transfer. This point is one important part of the discussion of differences between Gagne and the advocates of highly context-centered instruction.

Perkins and Salomon (1989) in essence have discussed the same issue, but in terms of the dichotomy between the roles of general strategic knowledge (i.e. decontexualized) and specialized domain knowledge (i.e. contextualized) as predictors of effective problem solving. They conclude that transfer is a highly specific phenomenon and while all specific applications need to consider contextual factors, there is a need to have an "intimate intermingling of generality and context-specificity in instruction" (p. 24). This seems not so very different from Gagne's position of embedding context within the instructional strategies, even though the ultimate goal is to facilitate far transfer.

There is a second aspect of Gagne's work and orientation that needs to be considered when discussing the role of context in promoting both transfer of training and long-term retention -- namely, the role of the enterprise schema (Gagne & Merrill, 1990). An enterprise is a complex *purposive* performance involving multiple, related instructional goals. It is a higher level goal than is frequently used in many education and training programs. An enterprise is represented in one's memory by a schema that relates these larger goals (typically presented as a realistic application task) to their prerequisite skills and knowledge. The schema is a mental model that serves as the basis for both retention and retrieval, as well as transfer.

The emphasis on integrated instructional goals corresponds with an emphasis on purposive, relevant instruction. While such instruction is designed with transfer in mind, it may not be authentic in the same sense promoted by advocates of situated cognition that seems to view learning as more of an enculturation process. The notions of integrated goals and enterprise schema tend to relate more to *generalized* transfer and a de-emphasis of declarative and procedural learning as an end unto itself. While Gagne would undoubtedly use contextualized examples and practice activities, it is unlikely that he would advocate always rooting instruction in a *single*, even though relevant, context. The most useful enterprise schema is somewhat generic, applicable to a variety of specific enterprises in which one might become engaged. Of course, much instruction, especially that of a training nature, is oriented only toward specific performance-oriented objectives that are more conducive to near transfer, and these situations often demand strategies which utilize a given context.

In summary, Gagne's orientation to context is not totally incompatible with current thinking insofar as it stems from a cognitive orientation. Gagne continues to strive for instruction that primarily addresses higher levels of learning and aspires to far reaching transfer as opposed to specific applications of content. Effective instruction is relevant to learners' needs as well as being appropriate to their skill levels, but probably shows application in a variety of contexts rather than being "anchored" in only one environment. While procedural knowledge is apt to be related to more specific uses, the goal, nonetheless, is that of using such knowledge in combination with other skills and knowledge for creative problem solving. Ultimately, Gagne's design theory is generic in nature. It is theory that is applicable to all contexts, all types of content, and all types of learners.

The Stability of the Gagne Orientation to Theory

A clear trend in design theory over the past fifty years has been its continual expansion. There is more research. There is more theory construction. Just as Gagne responded to those issues that were critical during his most productive years, today's scholars are responding to a new set of concerns. While it is evident that the new theorizing is at times charting new waters, for the most part new theory is not antithetical to the old and, it continues to build upon Gagne's foundational work. It is likely that Gagne's *primary* positions will remain current to the extent that:

- cognitive learning principles continue to be accepted;
- design continues to be viewed as a generic activity; and
- instructional content and strategies continue to be pre-specified and analyzed.

There are now alternatives to each of these perspectives that present radically new design orientations; although, they remain on the fringe of acceptability. Their acceptance as more mainstream theory could modify Gagne's impact on future theory development. However, at this time, such a scenario seems unlikely.

The Continuing Domination of Gagne Doctrines in Design Practice

As with theory, the world of design *practice* is also undergoing changes that were previously unanticipated. These changes are, on the whole, reactions to demands for increased design efficiency. Such concerns are especially reflected in current efforts to enhance the traditional instructional systems design models and to reduce design cycle time.

In the preface to the first edition of *The Conditions of Learning* Gagne (1965) indicated that the impetus for this book was to explain "what is known about the process of learning that can be put to use in designing better education" (p. v). This reflects the fundamentally practical nature of instructional design. From one edition to the next, *The Conditions of Learning* became increasingly more practice oriented, and the final edition included four chapters describing specific design and analysis procedures and techniques. The question now is basically the same as was posed with respect to his theoretical contributions. Will Gagne's design and development techniques continue to provide direction for the typical practitioner?

In the past much of his direction for practice has related to techniques for varying designs in terms of the type of learning task, for using learning hierarchies as a pre-design content analysis tool, and for using the events of instruction as a guide for the design of lessons and the selection of instructional strategies. Clearly these tactics are bi-products of Gagne design theory. While their continued use by the typical practitioner is dependent upon the stability of this underlying theory, such use is also greatly affected by the realities of the everyday world of work.

The Continuing Dominance of Conditions and Outcomes-Based Design

The core of Gagne's contributions to instructional design relates to the premise that learning is brought about by arranging different instructional conditions for different types of learning tasks. Gagne has identified five different domains of learning outcomes, and has suggested varying conditions that are likely to lead to a learner achieving each of these types of goals (Gagne 1965, 1972). This approach is foundational to most instructional design models. It is difficult in today's climate to imagine a field of instructional design without such an orientation.

While there is currently more advocacy of alternative design positions than has previously been the case, this principle seems to be essentially unchallenged by practicing designers. It is not that other instructional foundations have not been suggested, such as the developmental level of the learner, or the use of reinforcement. While Gagne's conditions of learning recognize the role of such elements, the basic principle remains -- instruction should vary depending upon what is to be learned.

> The only major dissension with respect to this position is voiced by constructivists who do not ...
> ... accept the assumption that types of learning can be identified independent of the content and the context of learning. Indeed, from a constructivist viewpoint it is not possible to isolate units of information or make a priori assumptions of how the information will be used. Facts are not simply facts to be remembered in isolation (Bednar et al., 1992, p. 23).

Gagne (as have most instructional designers) has often noted the futility of teaching isolated facts, even though he would nonetheless argue that such content can be classified. It is far more common today for the Gagne position to be supported with respect to this issue, and there is no indication that his basic premise will not remain essentially in tact. Other elements of design practice according to Gagne, however, are to some extent more debatable, even though they too are prevalent among practitioners.

The Continuing Dominance of Pre-Design Analysis

Gagne's emphasis on pre-design content analysis coincides with the tenets of general systems theory. The use of the learning hierarchy tool facilitates such analysis as well as the identification of necessary learner prerequisites. Today there are two seemingly opposing trends. The first is to expand the analysis stage to accommodate a wider range of design variables in an effort to promote transfer of training (Richey, 1995). The second is a recognition that many expert designers use other methods that do not depend upon such analysis (Tripp, 1994). Both trends are occurring in the midst of extreme pressure, especially in the world of business, to reduce the design cycle time.

Before predicting the continuing influence of Gagne with respect to pre-design analysis, it is important to try to do justice to his position. With respect to the use of analysis and the construction of learning hierarchies, Gagne has cautioned against rigid use of the technique. For example, he recognizes that a learning hierarchy is not necessarily the sequence by which an *individual* learner will acquire a particular capability, rather it is the most probable route to transfer of training for most people. He also cautions against emphasizing verbal knowledge in a hierarchy at the expense of the underlying intellectual skills.

These arguments (made over twenty-five years ago) may anticipate, at least in part, current analysis trends. The expansion of the analysis phase today represents not only the increased attention being given to learner characteristics and context, but also a new adherence to designing instruction focused upon larger content units. This latter move is, of course, consistent with Gagne and Merrill's (1990) advocacy of integrated goals as well as Gagne's initial position favoring hierarchies that focus on larger intellectual skills rather than discrete pieces of knowledge. The increased use of analysis is a direct extension of Gagne thinking, even though there may be some debate as to the legitimate focus of such analytic activity.

On the other hand, the findings of recent designer decision-making research draw a picture of expert designers working in a far less structured manner, responding spontaneously to situations which "trigger opportunistic excursions that yield unexpected insights into the problem" (Tripp, 1994, p. 117). However, Tripp also cites other research that shows designers using a *combination* of systematic analysis and opportunistic tactics. While Gagne has not specifically addressed this topic, it seems likely that he would support the latter approach.

Most designers today are under great pressure to produce a product in a shorter period of time than one would think realistic. While they know those procedures that are "textbook perfect", they face daily demands that they take shortcuts. The first steps to be slashed typically relate to evaluation and a detailed analysis of both content and needs. However, many designers are seeking ways to adhere to the time-proven methods and still be realistic in a business sense. Rather than sacrificing pre-design analysis standards, one salvation may be the use of computer-based design tools. Those tools that relate to content analysis, however, are based for the most part on Gagne techniques. Early work in this area has been completed by Gustafson and Reeves (1990) and Merrill, Li, and Jones (1990).

Another current effort to increase the efficiency, as well as the effectiveness, of the typical design task involves the use of rapid prototyping. Tripp and Bichelmeyer (1990) describe this methodology as one in which "after a succinct statement of needs and objectives, research and development are conducted as parallel processes that create prototypes, which are then tested and which may or may not evolve into a final product" (p. 35). As with the use of computer-based design, rapid prototyping builds upon traditional design practice although the stages are not linear in nature (Jones, Li, & Merrill, 1992). Content analysis in the Gagne tradition, however, is central to the early rapid prototyping stages in a similar fashion to its use in conventional systematic design. Other traditional design tools, many of which were introduced by Gagne, also have the ability to transcend current changes in our work environments. Many of these changes are precipitated by the availability of the new technologies, and even though Gagne's orientaion is not dominanted by technology it nonetheless accommodates technology's capabilities.

The Continuing Dominance of the Events of Instruction

Another important tool for designers has been the use of Gagne's Events of Instruction (Gagne, 1985, 1988; Gagne, Briggs, & Wager, 1992). The "Events" serve as a conceptual model for the design of lessons, the selection of instructional strategies, and the sequencing of instruction. In essence the "Events" summarize much of the key research related to instruction, including factors such as motivation, perception, feedback, reinforcement, individual differences, retention, and transfer. They provide a framework for creating those external conditions that promote learning.

Inherent in the "Events" is the notion of designer control of instructional options. While this is at odds with some constructivist theory, it is nonetheless consistent with the vast majority of the design practice in education and training environments today. The "Events" have been used regardless of the delivery medium, encompassing everything from stand-up training to computer-based instruction. For many expert designers the "Events" are now an internalized model that guides their work on a seemingly intuitive level. This is reflective of Duffy and Jonassen's (1991) assertion that "while instructional designers typically may not have the time or support to explicitly apply a theory of learning during a design or development task, the theory is nonetheless an integral part of the instruction that is produced" (p. 7).

While some may disagree on the particular strategy that is best for a given situation, there is little disagreement with the Events of Instruction themselves because they summarize key *stages* in the instructional process which have been repeatedly validated in the research literature. For example, conscious learning in a formal instructional environment requires attending to the topic and guidance, as well as reinforcement. While there are various strategies for accomplishing these tasks, one must be selected. As such, the general framework provided by the "Events" remains constant.

To a great extent the "Events" framework is likely to remain useful even in situations which have student-controlled sequencing of learning activities, as is more frequently the case in computer-based instruction. This is because the instructional events still need to be programmed and available for learner use. While it is likely that multiple strategies and activities will be incorporated into a particular piece of instruction, each of the various functions of instruction (as suggested by the "Events" model) must still be accommodated. Such structure is as appropriate for designing individualized environments, as it has proven to be for the design of teacher-directed instruction.

The Stability of Gagne's Orientation to Practice

Gagne has consistently argued that instructional design practice should be based upon what we know about human learning. This position is seemingly axiomatic. Since it is unclear to most that the field currently has a completely accurate view of all human learning, it is possible that the stability of Gagne's orientation to design practice is assured because of our tendency to combine ideas from a variety of plausible explanations of the learning process.

However, practice techniques, even when based upon complex theory, often tend to be streamlined and simplified. Perhaps this accounts for the fact that there has been less debate related to design practice than theory, and for many of Gagne's practice techniques to remain current even in the midst of great theoretical debate. Bednar, et al. (1992) are not satisfied with the field's tendency to create a patchwork collection of tools and techniques that have been abstracted from different (and often conflicting) theories being used in a given design project. They argue that this eclectic approach does *not* produce the most effective instruction.

In any case, Gagne's basic orientation has become ensconced in design tradition, even *with* the emergence of new theory. Most trained instructional designers select their design focus depending upon the nature of the learning task, and are likely to continue this practice. Most will continue to conduct some sort of pre-design content analysis as a precursor to sequencing and identification of prerequisite skills -- even if they not *overtly* use the learning hierarchy tool. Most will continue to select instructional strategies based upon a general Events of Instruction framework -- even if it is internalized and not consciously used. To some extent this begs the question of whether *expert* designers who demonstrate alternative design decision-making patterns are really deviating from the Gagne tradition or are still using the same principles.

If major deviations from the Gagne orientation do occur, it is typically because time limitations are posing barriers to their use. Such pressures are leading to a reexamination of design practice. However, most are directing their efforts towards ways of increasing design efficiency using the same basic orientation, rather than making a sharp break with past tradition. Dick (1993) calls this process the *enhancement* of the instructional systems design process. Even time saving design models such as Tessmer and Wedman's (1990) Layers of Necessity approach, which suggests a way to streamline the process given the demands of a given situation, does not radically change the fundamental orientation to design. Thus, it seems that the basic Gagne approach will continue to provide direction to the field, even given the likely changes and advancements in design tools and techniques.

Conclusion

Robert Gagne has substantially shaped a new field of instructional design during his career as a psychologist. He made enormous contributions and had an enormous impact as both a researcher and a practitioner. While design has been called a "linking science", Gagne himself has also served a linking role throughout his career. He has linked the heyday of behavioral psychology with the dominance of cognitive psychology. He has linked the field's emphasis on designing educational programs for children with an emphasis on designing training programs for adults in the military and in business settings. He has linked basic learning research to applied educational research. He has linked theory to practice.

In his more than 50 years of active work, Gagne explored the complex processes of learning and instruction, and explained them to generations of designers in a simple, understandable way. In the process he has demonstrated his true genius. Gagne's work was spurred on by important social events that highlighted its importance and need for the general public rather than only a small intellectual community. There was an urgent need for efficient, effective training early in World War II. The Sputnik crisis in the 1950's highlighted the need for American schools to reinforce mathematics and science education. American corporations looked to education and training as an avenue to retool their workforces and meet foreign competition. His research and the successful application of this research in a variety of settings provided evidence of its relevance and practicality. In addition, its legitimacy was rooted in scientific authority and superior academic credentials.

Gagne's ideas were part of other prominent intellectual movements over the years, including both behavioral and cognitive psychology, general systems theory, and the early explorations into the nature of instructional theory. He was a contemporary of other giants of the world of education scholarship, including persons such as Benjamin Bloom, Jerome Bruner, John Carroll, Robert Glaser, and Ralph Tyler. In retrospect, there was a social and intellectual climate in the United States that was conducive to the proliferation and acceptance of Gagne's work.

Today, the field of instructional design has grown. It has many areas of specialization, many delivery options, and many alternative theoretical perspectives that command considerable support. Furthermore, there are far more people involved in the field. This growth in itself is testament to Gagne's work. However, this more complex environment may greatly reduce the possibilities of one person alone exercising the same over-arching dominance of a Robert Gagne.

Yet Gagne's influence is surely attributed to more than "being in the right place at the right time". Ultimately, his influence is a product of the power of his ideas. His influence is a product of those seemingly simple principles which most of us are still re-examining and continuing to find that they provide new meaning and new direction. Is that not the power of an intellectual legacy? The ideas continue, and new generations meet them, become engaged, and have yet another "Eureka" experience.

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Title:

Feedback and Elaboration Within a Computer-Based Simulation: A Dual Coding Perspective

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Abstract: The purpose of this study was to explore how adult users interact and learn during a computer-based simulation given visual and verbal forms of feedback coupled with embedded elaborations of the content. A total of 52 college students interacted with a computer-based simulation of Newton's laws of motion in which they had control over the motion of a simple screen object — a ball. Two simulation conditions were studied, each differing in how the feedback of the ball's speed, direction, and position was represented: visual feedback consisted of animated graphics and verbal feedback consisted of numeric displays. In addition, half of the simulations were supplemented with elaborations of the content modeled by the simulation in order to investigate how to promote referential processing, a key component of dual coding theory. Results showed significant differences for both the use of the elaborations and simulations containing visual feedback in helping subjects gain both tacit and explicit understanding of the science principles. In addition to the quantitative analysis, a qualitative analysis was also conducted with 12 additional subjects. This analysis revealed interesting trends in how some subjects valued and used the elaborations and the two feedback representations of the simulation.

Physics has long been regarded as one of the most abstract and difficult subjects to learn. A common belief is that the students who do well in physics have a special aptitude for learning science and mathematics. It is easy to understand how many might believe that the only students who are going to "need" physics are future engineers and physicists. However, instead of reserving physics for a gifted few, many feel that technology offers the chance to change commonly help perceptions about who can or should learn physics (White, 1993). For example, complex systems such as physics can easily be modeled on desktop computers. Computer simulations make complex systems accessible for students of varying ages, abilities, and learning levels. The computer, instead of the student, can assume responsibility of processing the underlying mathematics in order to let the student begin exploring a complex system by first focusing on conceptual understanding.

Of course, many challenges to the *effective* design of simulations remain. Among the most difficult are questions about the design of a simulation's interface (Schneiderman, 1987). For example, designers currently can include a wide range of visual, textual, and aural elements in the development of simulations. As the range of available design options increases, so too does the complexity of design decisions. One of the most important considerations in a simulation's interface design is how to provide meaningful feedback to the user. Feedback has long been regarded by cognitive psychologists as one of the most critical sources of information to assist learners in restructuring their knowledge and supporting their metacognitive processes (Kulhavy & Wager, 1993). Given the range of ways computers can represent feedback in a simulation, research is needed to ensure that design decisions are made based on the psychological needs of the individual user and not simply on what the computer is capable of doing.

Much research demonstrates that the way information is represented matters greatly in the learning process, at least for memory tasks (Clark & Paivio, 1991; Paivio, 1990; Paivio, 1991). Research indicates that pictures are superior to words for remembering concrete concepts (Sadoski, Goetz & Fritz, 1993). Among the various theories that have been proposed to explain this, Paivio's dual coding theory appears to have the strongest empirical support (Anderson, 1978; Sadoski & Paivio, 1994; Sadoski, Paivio & Goetz, 1991). Dual coding theory divides cognition into two processing systems — one visual and one verbal. Although the research supporting dual coding theory is based almost exclusively on evidence derived from supplementing printed text with visuals (including paired associative tasks) (e.g., Sadoski, Goetz & Avila, 1995; Sadoski & Paivio, 1994), this theory also holds promise in guiding research in computer-based multimedia environments (Mayer & Sims, 1994; Rieber, in press).

Dual-coding theory predicts three separate levels of processing within and between the visual and verbal systems: representational, associative, and referential. Representational structures (either visual or verbal) are formed depending on the nature of incoming information (i.e., visual and verbal information from the environment triggers the visual and verbal systems respectively). Associative processing leads to connections constructed *within* either the visual or verbal systems, whereas referential processing leads to connections made *between* the visual and verbal systems. Referential processing is particularly important because dual coding theory predicts that learning will be enhanced when information is encoded in both systems (i.e., dually coded). Information that is dually coded has twice the chance to be retrieved and used (Kobayashi, 1986). Instruction that promotes dual coding has obvious advantages.

Our past research has shown that the way feedback is represented also matters when learning from simulations of physical science concepts and principles (i.e., laws of motion). Subjects increased their tacit knowledge of physics when they interacted with a physics simulation given visual feedback, but they were unable to demonstrate increased explicit understanding based on the way the feedback was represented (see Rieber, in press; Rieber et al., in press). Tacit understanding was measured by subjects' performance in a gamelike activity whereas explicit understanding was measured using a traditional performance test (i.e., multiple-choice question format). The increase in tacit learning given visual feedback indicated that representational and associative processing occurred almost exclusively *within* the visual system. Subjects' difficulty in acquiring explicit understanding of the physics principles modeled by the computer was attributed to the highly interactive nature of the discovery-based simulation. Simulations that model physical phenomena (such as physical science) may not provide the learner with sufficient time or guidance for interpreting the continual stream of feedback by *both* the visual and verbal systems. In other words, the "video game-like" quality of the simulation may have interfered with referential processing.

The purpose of this study was to investigate ways to facilitate or enhance referential processing as a user interacts with a computer simulation. Our previous research used a pure discovery-based approach — no instruction was included or embedded in the simulation. While the highly experiential nature of open-ended simulations appear beneficial in many ways, it does not seem to adequately promote reflection of the science principles. Reflection appears to be an important component for referential processing. Therefore, the use of brief elaborations of the science principles embedded throughout the user's experience with the simulation was studied in this research. It was hypothesized that supplementing the simulation with elaborations of the content would facilitate all three types of processing predicted by dual coding theory for explicit learning. Also, since previous research suggests the apparent dominance of the visual system during a user's interaction with simulations similar to these, it was also hypothesized that the embedded elaborations would promote more referential processing when subjects were given visual instead of verbal feedback.

A variety of data sources were used in this study. Traditional performance measures (e.g., question-based pretests and posttests) were used to assess subjects' explicit understanding of the science principles modeled in the simulation. However, such formal tests do not assess other levels of understanding which are embedded in a task. For example, bringing a car to a smooth controlled stop requires an extensive understanding of many motion principles. However, this understanding remains situated in the act of driving — the individual may not be able to explicitly describe the physical relationships at work. Although we recognize that a learner's ability to transfer conceptual understanding from one task to another (such as to a posttest) remains an important indication of learning, this study also used a measure of tacit understanding found useful in our earlier research. Subjects were asked to complete the simulation in a game-like context. Since an understanding of the motion principles is necessary to be successful at the game, the game score provides an alternative data source useful when compared with the subjects' scores on traditional performance measures. Finally, this study also included both a quantitative and qualitative phase. Rather than arguing in favor of one research methodology over another, we believe that the combination of methodologies provides a more complete understanding that either could provide separately.

Method

The quantitative methods and results of this study will be reported first, followed by the qualitative methods and results.

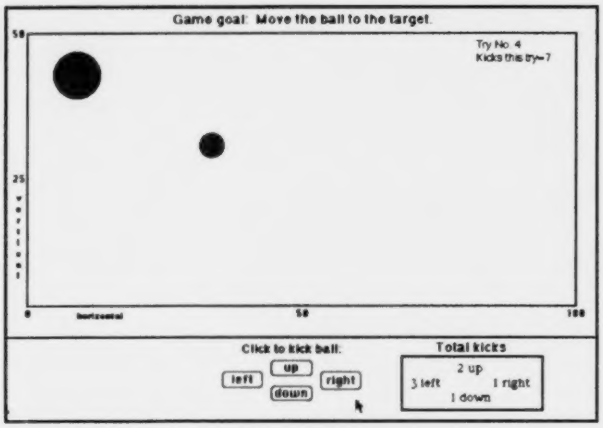
Subjects

A total of 52 subjects participated in the experimental phase of this study. Subjects were upperclass undergraduate students enrolled in an introductory computer education course. Participation was voluntary, though extra credit in the course was provided to students as incentive to participate.

Materials

The materials consisted of a computer-based simulation of Newton's laws of motion. Subjects had direct control over the motion of a simulated, free-floating object (called simply a "ball"). The simulation was presented in a game-like context with the goal of moving the ball to a specific screen location (called the "target"). All 52 subjects were given a total of 30 trials. It was anticipated that as subjects gained mastery of the game, they would become bored unless the challenge was increased. For the first 20 trials, all subjects merely had to guide the ball to the target. However, in the final 10 trials, all subjects had to guide the ball to the target *and* bring the ball to a stop while inside the target.

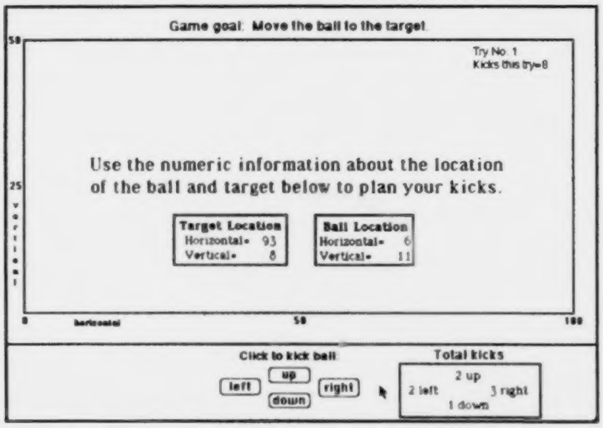
Subjects were able to move the object in two dimensions. They controlled the motion of the object by pressing one of four screen buttons that applied an impulse force to it, similar to a "kick," in one of four directions: left, right, up, or down. The magnitude of the force, or kick, did not vary. No other forces (e.g., gravity and friction) were included in the simulation. The computer calculated the resulting motion of the object (i.e., position, speed, and direction) and reported this information back to the user in real-time. In other words, the computer calculated the motion of the object about as fast as the user interacted with the simulation. The computer provided this information to the user in one of two ways, either as *visual* feedback or as *verbal* feedback. Visual feedback contained a graphic of the target and an animated graphic of the ball while verbal feedback consisted of numerical readouts of the screen positions of the ball and target. Half of the subjects were given visual feedback and the other half verbal feedback. Examples of these two forms of feedback are illustrated in Figures 1 and 2.


Game goal: Move the ball to the target.

Try No. 4
Kicks this try=7

Total kicks
2 up
3 left
1 right
1 down

Figure 1. Snapshot of the computer screen during the simulation in which visual feedback was provided. Feedback about the ball's position was displayed by animating the ball on the computer screen.


Game goal: Move the ball to the target.

Try No. 1
Kicks this try=8

Use the numeric information about the location of the ball and target below to plan your kicks.

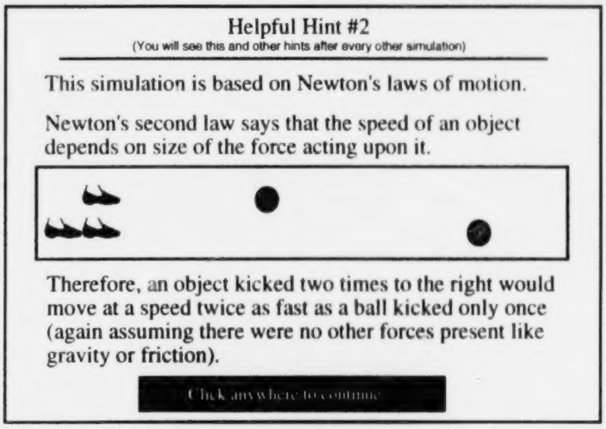
Target Location
Horizontal= 93
Vertical= 8

Ball Location
Horizontal= 6
Vertical= 11

Total kicks
2 up
2 left
3 right
1 down

Figure 2. Snapshot of the computer screen during the simulation in which verbal feedback was provided. Feedback about the ball's position was displayed only in numerical form.

Subjects were also randomly assigned to one of two levels of Elaboration (Yes, No). Elaboration consisted of five separate explanative frames that explicitly described the motion principles using a combination of text and animated graphics. The five frames were presented in sequence, one elaboration frame after every two simulation trials (e.g., elaboration frame 1 after simulation try 2, elaboration frame 2 after simulation try 4, etc.). Therefore, each of the five elaboration frames was presented three times throughout the simulation trials. Half of the subjects were given these elaborations and half were not. An example of one of the elaborations is illustrated in Figure 3.



Helpful Hint #2

(You will see this and other hints after every other simulation)

This simulation is based on Newton's laws of motion.

Newton's second law says that the speed of an object depends on size of the force acting upon it.

Therefore, an object kicked two times to the right would move at a speed twice as fast as a ball kicked only once (again assuming there were no other forces present like gravity or friction).

Figure 3. An example of one of the 5 embedded elaborations. The two balls were animated concurrently.

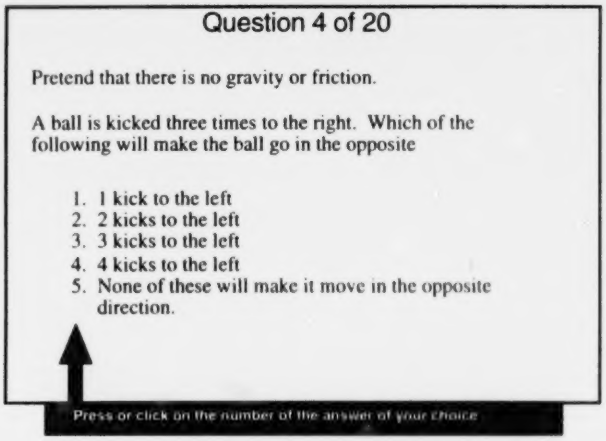
Dependent Measures

Performance. A 20-item test was used to measure subjects' explicit understanding of Newtonian motion principles. The questions were designed to test for rule-using learning outcomes (i.e., principles) (as defined by Gagné, Briggs & Wager, 1992). Multiple-choice questions (1 answer and 4 distractors) were used as the testing format. Representative questions are shown in Figure 4. KR-20 reliability was .85.

Game Score. The time, in seconds, taken by subjects to successfully complete the game was used as a scoring feature. A subject's score for any one simulation trial was equal to the number of seconds elapsed at the moment the game was completed. Each trial had a time limit of two minutes. If time ran out before the subjects successfully completed the game, the computer automatically signaled the end of the simulation and a score of 120 was recorded for that try.

Interactivity. The total number of times subjects clicked either the "right," "left," "up," or "down" button during each simulation was recorded by the computer.

Frustration. After each simulation trial, subjects were asked to rate their level of frustration on a scale of 0 to 8 where 0 was "no frustration," 8 was "extreme frustration."

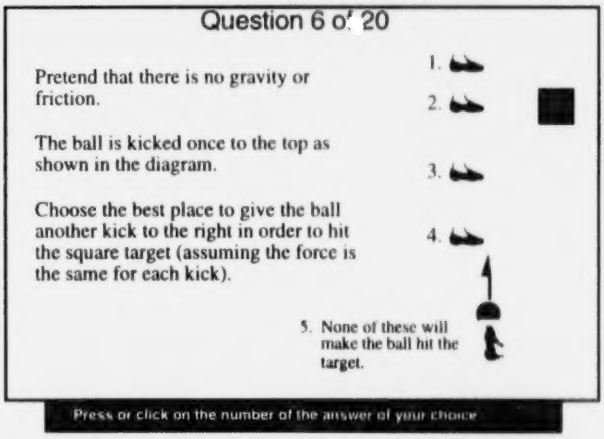

Question 4 of 20

Pretend that there is no gravity or friction.

A ball is kicked three times to the right. Which of the following will make the ball go in the opposite

1. 1 kick to the left
2. 2 kicks to the left
3. 3 kicks to the left
4. 4 kicks to the left
5. None of these will make it move in the opposite direction.

Press or click on the number of the answer of your choice


Question 6 of 20

Pretend that there is no gravity or friction.

The ball is kicked once to the top as shown in the diagram.

Choose the best place to give the ball another kick to the right in order to hit the square target (assuming the force is the same for each kick).

5. None of these will make the ball hit the target.

Press or click on the number of the answer of your choice

Figure 4. Two representative questions from the pretest/posttest. (The correct answer to the top question is "4" and the correct answer to the bottom question is "3".)

Procedures

All of the simulation conditions and testing were administered by the computer. Subjects were randomly assigned to one of the four conditions (i.e., visual or verbal feedback with or without embedded elaborations) as they reported to the computer lab. The computer immediately administered the 20-item pretest. Subjects were then given two practice trials with the simulation as an orientation to the task. Subjects then were given a total of 30 attempts with their respective simulation condition with or without embedded elaborations. After each simulation try, the computer surveyed subjects on their level of frustration. Immediately upon completion of the simulation activities, the computer automatically administered the posttest consisting of the same 20 multiple-choice items. Approximately one hour was needed to complete the experiment.

Design

This study used a 2x2 factorial design involving two levels of two between-subjects factors: Feedback (visual, verbal) and Elaboration (yes, no). Statistical procedures included separate Analysis of Variance (ANOVA) tests on each of the dependent measures (a repeated ANOVA was used on the pretest/posttest performance measure).

Results

Performance. Percentage means and standard deviations are contained in Table 1. A significant interaction was found between Elaboration and Performance, $F(1,48)=9.55$, $p<.01$, $MS_{error}=190.51$. All subjects scored similarly on the pretest (mean=53.2%), however, subjects provided with embedded elaborations scored higher on the posttest (mean=83.8%) than subjects who were not given the elaborations (mean=70.7%). There was also a significant interaction between Feedback and Performance, $F(1,48)=5.0$, $p<.05$, $MS_{error}=190.51$. Again, all subjects scored similarly on the pretest, however, those provided with visual feedback scored higher on the posttest (mean=84.8%) than those provided with verbal feedback (mean=69.8%). No interaction was found between Feedback and Elaboration: the embedded elaborations were equally beneficial to subjects regardless of which feedback type (visual or verbal) they were given in the simulation.

Given the main effects for both Elaboration and Feedback, a separate post hoc analysis was conducted on the simple effects between the four cell means using only the posttest scores to test for the additive effects of the elaborations combined with visual feedback. Results showed a significant difference between the four cell means, $F(3,48)=4.4$, $p<.01$, $MS_{error}=409.2$. Follow-up tests showed that subjects given both visual feedback during the simulation and the embedded elaborations scored significantly higher (mean=93.5%) than all other groups (mean=71.9%), as illustrated in Figure 5. Subjects given visual feedback combined with embedded elaborations attained near mastery on the posttest.

Game score. A significant main effect was found for Feedback, $F(1,48)=46.2$, $p<.0001$, $MS_{error}=223974.9$. Subjects given visual feedback scored better on the gaming activity than subjects provided with verbal feedback. This result is also consistent with previous research. Subjects level of tacit learning was facilitated more with visual feedback than verbal feedback. However, no significant differences were found for Elaboration: explicit information about Newton's laws of motion did not affect subjects' game scores in any way.

Interactivity. No main effects or interactions were found for Elaboration or Feedback. Subjects' frequency of interactivity (i.e., mouse clicks) was similar for all subjects in all treatment groups.

Frustration. A significant main effect was found for Feedback, $F(1,48)=12.9$, $p<.001$, $MS_{error}=2501.2$. Subjects provided with visual feedback were significantly less frustrated than subjects provided with verbal feedback. However, there was no main effect for Elaboration: the presence or absence of the elaboration did not affect subjects' frustration levels.

Qualitative Methods

Triangulation is regarded as one important way to strengthen the understanding of phenomena under study. This can be accomplished by using different kinds of methods or data, such as a combination of both quantitative and qualitative approaches (Mathison, 1988; Patton, 1990). The qualitative method used in this study was designed to complement the quantitative analysis in order to enhance the validity of our findings.

Interview, coupled with participant observation, were the two primary methods used to collect the qualitative data. An unstructured interview protocol was determined in advance but each interviewer was free to take the interview in any direction deemed necessary. Each member of the research team acted as an interviewer for at least one subject. Subjects were also asked to use a "think aloud" protocol to verbalize freely what they were thinking throughout their experience. The goal was to "get inside the participant's head" and elicit what they were doing and why.

Table 1

Mean Percentage Scores and Standard Deviations for Performance

Feedback		Performance	
		Pretest	Posttest
		With Embedded Elaborations	
Visual	M	55.0	93.5
	SD	18.6	9.0
	n	13	13
Verbal	M	47.7	74.2
	SD	27.1	28.0
	n	13	13
		Without Embedded Elaborations	
Visual	M	54.2	76.2
	SD	18.8	12.4
	n	13	13
Verbal	M	55.8	65.4
	SD	17.9	24.9
	n	13	13

Twelve subjects participated in the qualitative research (these subjects were drawn from the same population, but they did not participate in the quantitative phase). These subjects interacted with a modified version of the simulation used in the quantitative study. Subjects had complete control over the selection (when and which) of the embedded elaborations. Participants were also given total control over which feedback type was chosen for the first several trials. Thereafter, the interviewer negotiated with the subject as to which feedback type would be chosen in order to avoid having a subject experience only one feedback type (such as visual). In order for participants' experience to closely match that of subjects in the quantitative study, participants were expected to complete at least 30 trials. Participants in the qualitative study were also required to complete the pretest and posttest. No help was given to participants on the pretest and posttest. Nevertheless, during the posttest participants were encouraged to explain reasoning or confusing they were experiencing as they answered the questions.

Observational field notes were taken by each interviewer while the subject interacted with the simulation. The collected data were then examined by each interviewer for concepts and categories that emerged from sessions. Finally, the research team met as a group to compare, contrast, and synthesize the findings.

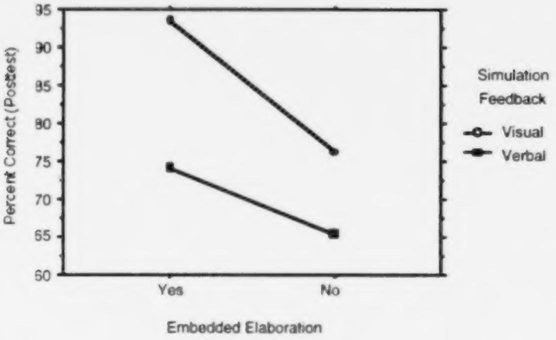


Figure 5. Means of subjects' posttest scores split by Elaboration and Feedback.

Results

Two themes were derived from the qualitative analysis related to the embedded elaborations and the simulation itself.

Embedded elaborations. There was a wide variation in how participants used and valued the elaborations. Almost all subjects thought that the embedded elaborations were beneficial, but most subjects did not feel that they were actually relying on the hints to any great extent in the simulation. However, an interesting pattern was noticed in several of the participants. They seem to be reassured that the elaborations were available even though they did not feel the need to consult them often. Still others were a little confused about how the hints were supposed to help them in the simulation as they did not see a strong connection. Most participants did not initially choose to click on the hints and instead opted to immediately begin interacting with simulation. However, several participants turned to the hints for help if they became disoriented in the gaming activity. Finally, participants tended to consult the hints sequentially and seldom consulted the same hint twice.

Interaction within the simulation. Almost all participants showed a strong preference for the visual feedback early on. However, this preference varied among individuals as they gained experience with the simulation. Two profiles of participants' reaction to the feedback were observed which we've chosen to name "clickers" and "strategists." Clickers did not employ any apparent strategies and either seemed just to be trying to complete the exercise or were interacting with the simulation in a very experiential way with little or no reflection. Strategists, in contrast, clearly were involved in building and testing strategies for improving their ability to play the game. Two distinct strategies emerged: one-dimensional versus diagonal. The one-dimensional strategy involved moving the ball along one dimension and stopping it when it lined up with the target. They then proceeded to move the ball to the target by way of the other dimension. The one-dimensional strategy seemed to work equally well in either feedback situation. In contrast, the diagonal strategy involved getting the ball to move along one dimension and then carefully timing when to give the ball another kick along the other dimension. Since the ball had not come to a stop, the ball resulted in a diagonal motion. This strategy tended to work well given visual feedback, but was often disorienting when given verbal feedback, especially if subjects missed the target on the first try. As to the relative benefits of these two types of feedback, one participant commented that "you have to think with textual feedback," while in graphical feedback "you can concentrate more on concepts without worrying about techniques." This comment reflects well the experiential nature of the visual feedback. It also demonstrates the tendency by many strategists to eventually switch their preference to the verbal feedback because it was more consistent with strategies they were developing plus it provided an extra challenge (most were getting bored after about 15 tries).

Discussion

The purpose of this study was to investigate ways to facilitate or enhance an individual's learning of physics principles while interacting with a computer simulation using a discovery-based approach. Many facets of learning were studied in this research, such as tacit versus explicit understanding as well as patterns of interactivity and frustration. While computers afford the design of highly interactive open-ended learning environments such as simulations, decisions about how to design the interface of a simulation are often made with little understanding of how the user will perceive, process, and interpret the resulting feedback that the simulation provides. This study was designed to explore the effects of some of the most basic interactive attributes of simulations on cognition.

Previous research on discovery learning in a computer simulation has shown that although the way a simulation's feedback is represented can greatly influence subjects' performance in game-like activities, differences in feedback did little to promote explicit understanding of the science principles necessary on traditional performance measures such as question and answer tests (Rieber, in press). The present study was designed to follow-up the results of Rieber (in press), but with some important changes. For example, subjects found the content of the simulation used in Rieber (in press) — acceleration and velocity — very demanding. The difficulty of the task may have interfered with understanding. In contrast, the simulation used in the present study involved a simpler model of Newtonian mechanics and was designed with greater sensitivity to motivation — challenge was increased at about the time subjects were expected to begin getting bored. This study also increased subjects' experience with the simulation — subjects had 30 separate trials with the simulation (as compared to 20 in previous research). The present study also included one additional factor — embedded elaborations — to investigate means of enhancing referential processing without seriously interrupting the interactive nature of the simulation (as would a complete tutorial).

This research was guided by dual-coding theory which predicts that more and effective learning should result when information is encoded both visually and verbally and if connections are made between these visual and verbal codes (Paivio, 1990). Information that is dually coded doubles the chance for retrieval since learners have two ways to access the information. According to dual coding theory these connections are established through referential processing. However, there has been little application of dual coding theory to simulations and other interactive learning environments. The highly interactive nature of many computer simulations creates an interesting dilemma. On one hand, the experiential nature of an educational simulation is very compelling — users often become very active and engaged in a simulation, similar to the experience of playing a video game. However, the intense and demanding interactivity of many simulations may not provide adequate time for the user to carefully reflect on the principles being modeled by the simulation. Without sufficient guidance or time and opportunity for reflection, referential processing may not take place. Therefore, while the simulation may lead to successful tacit learning (i.e., success at completing the simulation activities), the simulation may actually hinder or interfere with explicit learning. This research tried to gain insight to this issue by studying the influence of the way a simulation's feedback is represented in combination with the embedded elaborations.

In contrast to Rieber (in press), visual feedback (consisting of continually updated animated graphics) during a simulation was more effective than verbal feedback in helping subjects gain both tacit and explicit learning of Newton's laws of motion. Not only did the subjects who were given visual feedback outperform other subjects on the simulation's gaming activity (i.e., tacit knowledge), their gains from the pretest to the posttest were also greater.

The embedded elaborations were very successful learning aids even though they were exceedingly brief (one frame each). Subjects who given the elaborations gained significantly more explicit understanding of the science principles than those who were not given the elaborations. Not surprisingly, the elaborations were of little help to subjects as they played the game. From a dual coding perspective, the elaborations in tandem with the simulations promoted representational, associative, *and* referential processing. The elaborations were equally beneficial to all subjects — there were no differentiated effects based on the type of feedback provided. This was surprising. It was expected that subjects given the visual feedback would be in a better position to make meaning out of the embedded elaboration than subjects given the verbal feedback. Of course, the embedded elaborations used here contained both visual and verbal elements. The elaborations may have influenced mental imaging for subjects given verbal feedback. The qualitative results, however, suggest that although subjects thought the elaborations were generally beneficial, they tended not to use the elaborations much because they did not see them as an aid in achieving greater success at the game. Subjects largely failed to focus on the more global goal of using the simulation *and* the elaborations as a means of learning about the laws of motion. The phenomena of users not choosing to select options from which they clearly could benefit is reminiscent of the research on learner control (Clark, 1982; Milheim & Martin, 1991; Steinberg, 1989).

The additive effects of the visual feedback coupled with embedded elaborations deserves special attention. As indicated in the post hoc analysis of the simple effects on the posttest, subjects given both visual feedback and elaborations reached near mastery on the posttest (average score of 93.5%), outperforming all other subjects. These results, though still preliminary, suggest an interesting approach to optimizing the experience of learning by simulation. Unlike traditional approaches where simulations are usually used as follow-up practice activities to tutorials (see, for example, Alessi & Trollip, 1991), it may be possible to center learning around the highly interactive and experiential nature of a simulation. Certainly, there seem to be cognitive advantages to students making meaning through personal discovery and exploration. Every "secret" they discover, recognize, and articulate becomes *their* knowledge, not someone else's. Of course, the promise of personally constructed knowledge comes with increased responsibility on the part of each learner. Computer simulations afford learners with the chance to interact with information-laden representations of complex domains (e.g., physics, mathematics, chemistry, history, etc.). In many simulations, students face the burden of making meaning from a continual stream of information about the physical properties of screen objects. These results suggest a way to supplement a simulation to help students meet the difficult task of learning in a simulation.

It is important to note the task specific nature of the visual representation of feedback produced by a computer simulation. A conclusion of this study is that different representations will lead to different outcomes for certain tasks and *not* that visual feedback is generally "better" than verbal feedback for *all* tasks. The design challenge is to match the demands of the task with appropriate representations. Certainly in this study, the visual feedback was very consistent with learning about the laws of motion. However, as the qualitative data suggest, many "strategists" often came to prefer the verbal feedback after sufficient experience with the simulation because they began to develop creative strategies to further their success and enjoyment in playing the game.

The lack of main effects on interactivity is in contrast to that found in previous research (Rieber, in press; Rieber et al., in press). Previous research found that subjects interacted far less when given visual feedback even though their game scores were better. This difference is probably due to the simpler nature of the simulation and backs up the hypothesis that subjects often increase their level of overt interactivity when disoriented (users seem to revert to "frantic clicking"). The fact that subjects reported being more frustrated when given verbal instead of visual feedback is consistent with our previous research. Visual feedback is much preferred by subjects given such physics simulations. The relationship between imagery and motivation is also consistent with dual coding theory (Clark & Paivio, 1991). Of course, the qualitative data suggesting that some (but not all) subjects eventually switch their preference to verbal feedback to match certain strategies they are constructing attests to the need to design simulations with a range of feedback options.

Several questions for future research remain. More research is needed on the effects of the visual and verbal elements of the embedded elaborations so as to better understand how they interact with different feedback representations in the simulation. Also, more precise information on the contribution of the embedded elaborations *versus* the simulation experience is needed. That is, the issue of how much learning is taking place just by having subjects view the elaborations *without* participating in the simulation is open to question. Future research should also expand on the delicate demands of optimizing challenge to maintain motivation in game-like activities embedded in a simulation (see Lepper & Malone, 1987) and the use of certain games as measures of tacit knowledge.

In conclusion, the results of this study point to a simple yet powerful means of facilitating referential processing in a simulation. The use of simple elaborations of the content modeled by a simulation coupled with appropriate matching of the simulation's feedback to the task appears to be a surprisingly effective way to guide students to focus on the most important principles in the simulation without subverting personal discovery or risking decreased motivation. The qualitative data, however, tempers this enthusiasm by reminding us of the complex way a user perceives value and relevance to these elaborations. Users may feel reassured that additional guidance is available, but yet may not choose to consult such help at appropriate times if they fail to see the connection of how embedded elaborations will lead to greater success in completing a simulation or game.

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Title:

An Exploration of the World Wide Web: Art Images and Visual Literacy

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Images surround us, overwhelm us, influence, entertain, inform, warn, direct, delight, and enlighten us. While academia is a verbal enterprise, our world is a visual, sensory one. Those of us interested and involved with visual literacy are dedicated to helping society recognize the power of visuals and produce more meaningful visual displays. Courses, texts, and conference sessions help students become more visually "literate", able to communicate, understand, and produce communication visually.

The introduction of affordable multimedia computers with CD-ROM capacity, VCR's, and connections to the Internet and the World Wide Web have created an even greater opportunity to help society develop visual literacy. These technologies are a rich, varied, and inexpensive source for an almost infinite variety of images, including but not limited to graphics, photographs, scientific displays, computer-generated art, fine art reproductions, instructional graphics, consumer produced images, click art, and so on.

In addition to its ease and low cost, the World Wide Web has increasing popularity as one of its main characteristics. Businesses and schools are creating their own home pages, and "everyone" wants to be "on the Web". Given all this, we felt a responsibility to help society and our students with the visual issues related to the World Wide Web. We added to a course taught in our Instructional Technology program on Visual Literacy, and designed the course to enable students to use the WWW as a resource for their assignments and activities. In this paper we provide the following:

1. Introduction and background to using the World Wide Web images in teaching visual literacy;

2. A brief historical overview to images in education;

3. An overview of one approach to analyzing visuals; and

4. Locations of a variety of useful images found on the Web which may be especially helpful for others.

Teaching Visual Literacy

Many courses in visual literacy exist at universities across the country. Often these courses are directed at art students, education majors, and in-service teachers, who work with the ideas in developing their own artistic creations or teaching materials. The course we taught is in instructional technology, and is directed at students who would then apply the concepts to creating either student materials (instructional design) or teaching materials for any level student. The course has at its goal the overall improvement of the students' visual literacy, especially their ability to use and interpret visual information and messages for communication. The assignments in the course include finding, selecting and analyzing many different visuals from a variety of sources, including click art, CD-ROMs, film, video and television, and the World Wide Web. Students also analyzed and created visuals intended to inform and persuade viewers, such as ads and posters. As this was an introductory course, use of the computer resources and technologies was limited by laboratory availability; students needed to work in a learning center or other location outside of class time. The assignment to use the WWW was very well received by students; they are as noted above very excited about learning this latest technology. In introducing the variety of visual resources now available, we also reviewed for students the history of the visual education movement in the US as it relates to the teaching of Visual Literacy now.

Historical Overview

An early session of the course focused on the beginnings of visual literacy, the visual education movement in the US. One perspective we shared involved the changing role of the media specialist, or visual curator, as our field developed from visuals in collections and became more involved with their use in education. For example, the museum as an institution in the United States has a long standing tradition. Our first museum was established by Charles Wilson Peale and is documented by his 1822 self-portrait *The Artist in his Museum.* The earliest examples of the visual instruction movement are demonstrated by the development of museum/school interaction. The end of the nineteenth century and the beginning of the twentieth was a time of extraordinary growth for United States museums. This fact is evidenced by the following list of museums: in 1880 the Metropolitan Museum of Art was opened in New York City; in 1905 the St. Louis Museum was established with strong links to the school system; the Cleveland Museum of Art was opened in 1909; and Chicago's Field Museum opened in 1911, to name just a few of the major institutions. The types of student experiences established by the museum/school interactions became the basis for Hoban's 1937 book *Visualizing the Curriculum*. His theory explains why these experiences were important. Essentially, Hoban states that the first level of learning occurs when there is interaction with the actual object. This type of interaction has also been the most important when dealing with a work of art.

Another important aspect of the Visual Instruction Movement was the use of slides and film in education. As early as 1895, Chicago school principals realized the importance of visual instruction. They used personal funds to establish a slide collection for their schools' use. By 1917 they had amassed over 8,000 slides and donated the collection to the School Board for district wide circulation. Also by this time there was a visual instruction course included in teacher education preparation at the University of Minnesota.

Effects of Specialization

It would appear that visual instruction was becoming an integral part of the nations' education. However, with the introduction of various media, slides and film, there developed the specialization in production and administration of materials. This technology specialization separated the visual instruction component from classroom delivery. A new territory was created, that of the specialist. Visual instruction ownership moved from the teachers to the specialist. The scenario that appeared was one of the teacher having to go to the specialist for the images. (This presentation was illustrated by art images from the Art Department collection). An art image that comes to mind is that of Ingres' *Jupiter and Thetis*. In this nineteenth century painting Thetis is clearly begging Jupiter for favors. In the past, libraries or visual resource centers often guarded their materials rather than share them. The specialist could wield power over the distribution of images much like the power displayed in this image of Jupiter. This isolationist philosophy of some specialists may have lead in part to the decline of the visual instruction movement.

According to Saettler (1990), the decline of the visual instruction movement occurred after World War II. Then current communication models explored the concrete-abstract continuum first outlined by Hoban (1937) and later defined by Dale's Cone of Experience. However, these models were not reflected in the specialists' philosophy. These first Instructional Technologists had become a small, isolated group of people who enjoyed top-level decision making positions in regard to administrative functions and the production of visual instruction, but who ignored current, relevant psychological theories. This decline could be illustrated by Thomas Couture's *Romans of Decadence*. Like the Roman's who lived only in Rome, isolating themselves from the outlying areas, the visual specialists took on a role of authority and power separating themselves from the educators.

The paradigm shift that occurred in the 1970s from behaviorism to cognition provided a new role for visual instruction. Olson and Bruner stated that, "instructional media, therefore cannot be chosen simply in terms of their ability to convey certain kinds of content, but also be chosen in terms of their ability to develop the processing skills that make up such an important part of human intelligence" (Saettler, 1990, p.440). The focus then in this new paradigm shifted from the media like film (i.e. what is the film doing to the learner) to the thought processes involved in evaluating that film or image. Depth of processing could then be used to evaluate images; consequently, the technology or medium c/should become transparent to a point. This paradigm shift breathed new life into the visual instruction movement, which has been renamed visual literacy since 1969.

Analyzing Visual Messages-A Construct

Visual literacy research can provide a structural framework for courses such as Visual Literacy or Introduction to the Visual Arts. Barbara Fredette's research combined with the theories of Arnheim and Feldman create her approach to reading pictures or images (Fredette, 1994). Her method demonstrates a depth of thought processing which can be applied to this course. Fredette describes the process in four steps; description, analysis of form, creative interpretation and critical interpretation. She states that based on her research with students, viewers go through each of these processes in the order stated and that this order represents an hierarchy of thought processing.

It has been our experience with college level students over the past five years that they process a work of art in a slightly different manner. They use the same four steps but process them in a slightly different order; description, creative interpretation, analysis of from and critical interpretation. We believe they change this order for the following reasons. Students have the ability to provide a description and a creative interpretation without any additional information. They can describe images, shapes, color and lines. They also readily apply their own knowledge to the art work as they attempt to 'make sense' of it within their own experiences. However, analysis of form demands that they know/learn the terminology of analysis and that they can apply those terms to works previously unseen. This process develops critical thinking skills. Secondly, they must bring with them some research skills for the fourth level , the critical interpretation of a work. Viewers must find the resources necessary to provide themselves with additional information, such as culture, iconography and relationship to the media. Hopefully they will become more informed viewers about the work of art.

In conclusion, Fredette's framework, modified, provides a solid structure for the students in introductory visual arts courses. The students need to understand which level of explication is currently being used in their classroom setting, and need to be able to work between levels to help themselves fully understand a visual work and expand their visual literacy.

Using the World Wide Web

Many Web sites have been located which could be shared with students and used for visual examples in classes. Our students drew from these sources and others to analyze and present their ideas in class. Since the Web is ever-changing, the list presented is of course dated as we print it out. But these sources should help lead to others current at the time of use. (Examples from the following sites were shared using slides copied from files taken from the Web).

Art related Websites (fall, 1996)

World Wide Arts Resource
http://www.concourse.com/wwar/default.html

ArtServe, Australian National University.
http://rubens.anu.edu.au

AIDS Memorial Quilt Website
http://www.aidsquilt.org/

Ansel Adams
http://www.book.uci.edu/AdamsHome.html

Asian Arts
http://www.webart.com/asianart/index.html

Christo's and Jeanne-Claude's homepage
http://pomo.nbn.com/youcan/christo/index.htm

Christus Rex the Vatican museums
http://www.christusrex.org/

Frida Kahlo
http://www.cascade.net/kahlo.html

Indianapolis Museum of Art
http://www.otisnet.com/ima

Institute of Egyptian Art and Archaelogy
http://www.memst.edu/egypt/main.html

International Visual Literacy Association
http://www.emporia.edu/S/www/slim/resource/IVLA/IVLA.htm

Le WebMuseum
http://www.emf.net/wm/

Minneapolis Institute of Arts
http://www.mtn.org/MIA/mia_intro.html#index.

Museum of Bad Art
http://glyphs.com/moba/

National Museum of African Art
http://www.si.edu/organiza/museums/africart/start.htm

National Museum of Slovenia
http://stenar.arnes.si/guest/ljnarodnim4/ang/index.html

On-Line Visual Literacy Project
http://www.pomona.claremont.edu/visual-lit/intro.html

Oriental Institute Museum
http://www-oi.uchicago.edu/

Prehistoric caves at Vallon-Pont-d'Arc
http://www.culture.fr/culture/gvpda-en.htm.

Surrealism
http://pharmdec.wustl.edu/juju/surr/surrealism.html

Teaching Contemporary Art:Sandy Skoglund
http:/www.artsednet.getty.edu/

Andy Warhol
http://www.warhol.org/warhol/warhol.html

Women Artists Archive
http://www.sonoma.edu/library/waa/

World Art Treasures
http://sgwww.epfl.ch/BERGER/index.html

Summary

Art images are a natural choice for the teaching of visual literacy. Many academic settings have art collections available, but students do not always have such access. The history of the visual instruction movement may not be familiar to many students in educational technology, who may think that visuals were newly introduced with television and computer software. The historical perspective summarized here is one that helps students understand the importance and acceptance of the visual instruction perspective. In addition, the use of new technologies makes the teaching of visual literacy more current and viable for instructional technology students. It is hoped that the background, analysis techniques, and Web sites included here make the teaching of visual literacy more interesting and valuable for others.

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Title:

A Constructivist Design and Learning Model: Time for a Graphic

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Introduction

The current uproar that is the field of education in the 1990's seems to place almost every aspect of teaching and learning into question. The battles that stem from major philosophic differences tend to permeate not only educational philosophies and research, but curriculum development and instructional practice as well. In instructional design, such philosophic debate has manifested as a tension between instructivist and constructivist approaches. Designing instruction, in this environment, becomes a statement of the underlying assumptions about knowledge and learning held by the designer and the client, as well as a definition of the roles of the teacher and students who experience the instruction.

Even though the instructivist and constructivist instructional design approaches appear to be at odds, attempts have been made to marry the two:

> For ID [instructional design], this means primarily re-integrating design with instructional delivery so that the interaction between student and instruction becomes more adaptive to situations that vary from one problem to the next. It also means the development of learning environments in which students construct knowledge for themselves. For their part, proponents of SL [situated learning] need to develop effective ways for bringing authentic activity into the classroom.... I expect that with a serious attempt to adapt ID to SL and vice versa, powerful and innovative learning environments can be built to the benefit of all who work in them (Winn, 1993, p. 20).

At the 1995 AECT National Convention, three different presentations on constructivist instructional design were offered which attempted to answer Winn's call for "innovative learning environments" and the merger of instructivist and constructivist design: (a) the "Layers of Negotiation Model" (Cennamo, Abell, & Chung, 1995), (b) a design for graduate school courses (Wager, Lebow, Driscoll, & Supinski, 1995), and (c) a design for a series of business courses (Cognitive Learning Group, 1995). Though all three presentations were clearly based on both constructivist theory and on recommendations from the literature, such as Driscoll's (1994) five conditions for constructivist learning environments, no attempt was made to present a visual model. Cennamo et al., (1995) came closest when they described the Layers of Negotiation Model as a spiral, yet they did not offer a graphic representation of the spiral process.

While visual or graphic models in instructional design that follow an instructivist philosophy are readily available (Dick & Carey, 1990; Gagné, Briggs, & Wager, 1992), participants in the philosophical debates, theoretical discussions, and design efforts in constructivist learning environments have not, to our knowledge, produced a visual representation of constructivist instructional design. One might, at first blush, question the need for another instructional design model. Yet, when we were faced with designing and developing our own new courses following a constructivist philosophy; we found that a model, visual representation, or "graphic" that incorporated both a systematic design process and a constructivist approach could provide a useful framework for efficient design.

In this paper, we present our design processes for two different learning contexts. These processes are based in part on the inspiration gained from the presentations of Cennamo et al., Wager et al., and the Cognitive Learning Group at the 1995 AECT convention. We also draw upon instructional design research and on the larger community of educational research to (a) present a three-part design framework based on the core instructional models first proposed by Sylvia Farnham-Diggory (1994) and the stages of learning described by Jonassen (1991a), (b) examine the framework's integrity and usefulness by asking five questions first posed by Dick and Carey (1990) and explored by Dunn in his review of constructivist philosophy (Dunn, 1994) , and (c) briefly describe how the framework answers questions that concern learning raised in constructivist/instructivist discussions (Driscoll, 1994; Jonassen, 1991b).

We must hasten to state that we are not interested in prescribing a series of events or designing from discrete stages (Cennamo et al., 1995) in our presentation of a constructivist model of instructional design. Instead, we approach a constructivist model of instructional design both from the design perspective and from the learner's context. In considering constructivist instructional design, or more accurately, *instructional context design*, the larger contexts of designer, teacher, and learner are incorporated into a framework that supports a context-sensitive teaching/learning environment rather than a prescriptive recipe for delivering content.

This concept of our visual representation as a framework rather than a prescriptive model for constructivist educational design is important. Rather than establish a specific set of steps, we envision a *supportive structure*, within which constructivist design might take place. This supportive structure is similar in spirit to Constructivist art of the 1920's with its "emphasis upon the structural aspect of the work of art [which] led to the concept of constructed art" (Hamilton, 1972,p. 235). Similarly in constructivist instructional design, the design framework with its focus on the context of learning, promotes the construction of learning within each context.

Origins of the Concept

Reflecting on our past instructional design projects, we recalled that the design models which had been most helpful to us were those which provided a direct connection between design steps and an organized approach to learning theory. The "Stages in Designing Instructional Systems," as integrated with Gagné's "Events of Instruction" (Gagné, et al., 1992) was favored by one of us in early instructional design projects. The other used Tennyson and Rasch's "Instructional Planning Model," which offered "a model of instructional design that links various forms of cognitive learning to appropriate methods of instruction" (Tennyson & Rasch, 1988, p. 369).

While the experiences reported by Cennamo et al., Wager et al., and the Cognitive Learning Group made it clear that constructivist design could not be reduced to a linear series of prescribed steps, we approached our consideration of a framework for instructional context design with the belief that, even in a non-linear design process, a conceptual link to learning theory remained vital. However, taxonomies or lists of learning conditions seemed more congruent with linear design models than with the spiraling or layered process of constructivist design that the various presenters at the 1995 AECT convention described.

Therefore, we sought a non-hierarchical conceptual model of learning theory which would be simple, inclusive, and flexible. We found that combination of characteristics in the three core instructional models (linked to five types of acquired knowledge) described and delimited by Sylvia Farnham-Diggory in her 1994 analysis of educational research literature. Farnham-Diggory maintains that:

> Every instructional program ... can be described as fitting one of three mutually exclusive models ... *behavior, development*, or *apprenticeship*. ... [T]he nature of the model is determined by two factors: how the model distinguishes novices from experts and what the mechanism of transformation is (1994, p. 464).

In the behavior model, novices are distinguished from experts by quantitative differences on the same scale. The mechanism of transformation is what Farnham-Diggory terms "incrementation," getting better, faster, or going higher on a quantitative scale. The development model distinguishes between experts and novices by differences in qualitative measures, such as personal beliefs and attitudes. The change is accomplished through "perturbation," the challenging of personal theory.

In the apprenticeship model, "experts and novices are from different worlds" (p. 466). The transformative process is "acculturation," that is, one learns about expertise by living in the culture of the expert. Farnham-Diggory maintains that within each of these three instructional models, any of five types of knowledge can be acquired: declarative, procedural, conceptual, analogical, and logical

As we began to create our visual representation of constructivist instructional design, we were guided by David Jonassen's assertion that designers cannot always control what individuals learn, but that they can aspire to design environments which support learners in their learning (Jonassen, 1991a). We adopted his concept of three stages of knowledge acquisition (initial, advanced, expertise) (Jonassen, 1991b), each entailing different types of learning (practice/feedback for the initial stage of learning, apprenticeship/coaching for the advanced stage, experience for the expert stage), the whole forming a continuum of learning and experience. These stages, used in conjunction with the Farnham-Diggory instructional models, illustrate the multiple combinations of learner characteristics, instructional approaches, and content types which can interact in an instructional context, and which must be addressed in the design process.

The task for a constructivist designer is to create an instructional context rich in experiences which, in interaction with the learner, may provide for the development of expertise. We use the terms "expert" and "novice" relatively, as does Farnham-Diggory (1994, p. 464). One could, for example, be expert at recognizing the upper case "A", or be a novice at diagnosing a particular variety of influenza. The instructional context designed for learners in each situation might draw on a combination of the instructional models in creating an environment supportive of the learner's development within that content domain.

While Farnham-Diggory defines the three instructional models as mutually exclusive, she recognizes that more than one can function concurrently within an instructional program. Current research (Eisner, 1993; Salomon, 1991) suggests that sharp delimiters between such models or levels are rare in real learning contexts. Within the same content domain, learners may be novices in some elements and more expert at other elements, yet overall be categorized at a developmental stage within the larger focus of the domain (two examples will be discussed later in the paper). With this in mind, we attempted to include in our visualization of instructional context design some means of illustrating the gray areas between and among the three core learning models and the stages of knowledge acquisition.

Creating the Visualization

Learning context, with all of its gray areas, complexities, and uncontrollable variables, became the focus of our conceptual model. The challenge from Winn (1993) to create "innovative learning environments" (p. 20), and the process of "spiral cycles rather than discreet stages" described by Cennamo et al. (1995, p.40), shaped our concept of an instructional context as a circular "tunnel" through which the learner passes while experiencing the lesson, course, or instructional system (see Figure 1). Within the tunnel, all experiences, materials, interactions, and communications, combine with the learner's prior knowledge to create the instructional context which is designed with the intent of stimulating the learner to construct knowledge relevant to the goals of the learning experience. As learners pass through the instructional context tunnel, they will progress from the novice level to some level of greater expertise in the relevant content domain. Thus the concept of a spiral tunnel attempts to include variables that enter into any learning context as well as the intended content of the learning experience.

Viewed over time, that is, over the length of the course, semester, or learning experience; the tunnel appears as an expanded coil spring through the center of which the learner passes as time passes in the learning environment (see Figure 2). The spiral bands represent the three core instructional models as they are cycled through repeatedly by the learner during the process of experiencing the learning context over time. The overall tunnel segment (from the "beginning" of the instruction to the "end" of instruction) represents the gradual progress through the novice, advanced, and expert levels of learning.

Figure 1. A cross-sectional view of the Instructional Context Design tunnel illustrating three core instructional paradigms at any point in time.

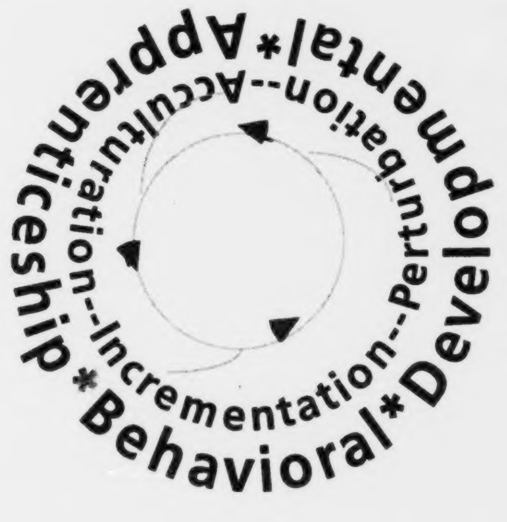
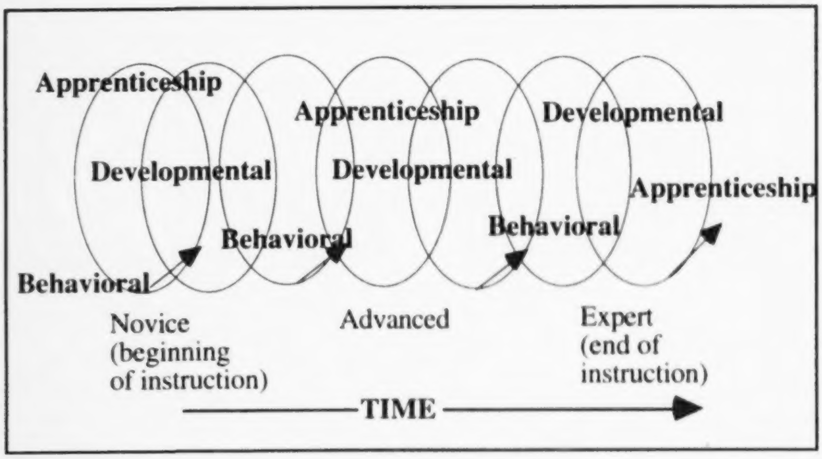

Apprenticeship*Behavioral*Developmental*
Acculturation--Incrementation--Perturbation--

Figure 2. A side view of the Instructional Context Design tunnel illustrating the repeating process of moving through novice, advanced, and expert stages of knowledge acquisition over time.



Having visualized the spiral tunnel, we set out to apply it to the instructional design projects in which we were involved: the first in a K-12 setting, the second in a university course. We did not intend to abandon traditional design questions, but hoped, like Cennamo et al. (1995), to shift the emphasis from procedures to process. Beginning at the expert/exit end of the tunnel, we anticipated examining the expert culture for that content domain, and then working back through the spiral to the point at which the novice learner enters the instructional context. As we moved through the tunnel, we hoped to follow the spiral as it wound around the tunnel wall, identifying the specific instructional models most appropriate to the stage of knowledge acquisition represented at each point of the process.

The next two sections describe the experiences each of us had in applying the Instructional Context Design framework (hereafter referred to as ICD). We offer these personal accounts, not as formal research in instructional design, but as real world applications of the framework in the hope of promoting further discussion of, and reflection on, the process of applying a constructivist approach to the design process.

Design into Practice in a K-12 Setting

As an instructional consultant in an elementary school, I am frequently involved with teachers in developing lessons and units of instruction. A teacher will often approach me with an instructional problem, and we will collaborate in creating materials or planning learning activities to address the problem. Since first visualizing the spiral tunnel approach to ICD, I have had several opportunities to apply this process in design projects with teachers.

In one case, a fifth grade teacher approached me with a problem in the reading and language arts curriculum areas. The district curriculum required that a specific research process be taught, and that an example of research writing be included in each student's portfolio. The teacher reported that the research process took up too much instructional time, that the student writing was of poor quality, and that most students, even those who generally enjoyed writing, disliked the research writing process. The challenge was to develop an instructional unit which could be completed by students in about two weeks, which would include the processes and products required by the district curriculum guide, and which would be motivating for more of the students.

We began our design process by visualizing the exit of the tunnel, exploring together the components of the culture of the expert research writer at this level. We consulted curriculum guides, student research writing from past classes, fifth grade student writers, and the experiences of several writing teachers as we constructed our image of the knowledge base, behaviors, attitudes, and products which might characterize a skilled and competent research writer. As we uncovered these characteristics, we were concurrently engaging in a dialogue about the setting in which these expert qualities would be likely to flourish - the cultural context of the expert fifth grade research writer.

As we approached consensus on our vision of the tunnel exit and the emerging expert research writer, we shifted our focus toward visualizing the spiraling tunnel from above. In this phase of the process, we discussed what combination of instructional models might best support a learner moving through the tunnel, engaging in the process of repeatedly cycling through stages of knowledge acquisition. Shifting our visualization to the tunnel's tri-shaded walls as viewed from its entrance reminded us that at any point in the instructional context, the learner might have need for behavioral, developmental, or apprenticeship instruction. Changing perspective again to visualize the smaller tri-colored bands spiraling around the coils of the tunnel wall helped us to remember that at any point in the instructional process the learner might be functioning as novice, advanced learner, or expert, relative to any particular element of the instructional context. As this phase of visualization proceeded, I became very conscious of Cennamo's comments about the necessity of embracing the complexity of the design process.

The case of the fifth grade research writing project was typical of my experiences using the spiral tunnel visualization, in that just as all the spirals and the considerations they represented began to feel too confusing, the confusion crystallized into some obvious and relatively simple answers. This stage, which I think of as the third and final stage of the visualization process, feels to me both non-linear and systematic. I visualize it as having completed construction of a three dimensional scale model of the tunnel (and the instructional context it represents). At this stage, we can peer into the entrance and exit, and peek through the spiraling walls at any point along their course.

The following paragraph of instructions was the end result of the peeking and poking in the ICD tunnel we constructed for the fifth grade research writing project. These directions were supported by a two-page form, some teacher modeling, a few reference materials, and some student collaboration:

> "You have been hired as a writer by National Geographic World magazine. Your assignment is to write a twenty page short story about a child your age who lives in one of the fifty United States and who has an adventure involving a wild animal. You will soon receive your expense account money and a round trip plane ticket to the state of your choice. Before you leave on this writing assignment, you must provide the magazine editors with a completed story proposal which must include accurate background information on the setting and characters of your proposed story, and a summary of the plot. The editors need your completed story in time to publish it in the September issue, so your plot summary must be on our desk no later than two weeks from today."

The instructional delivery for these materials differed greatly from the previous standard for fifth grade research writing instruction. Faced with an engaging challenge, students collaborated with their teacher and with each other to locate and explore useful reference sources. The teacher modeled the necessary information gathering and organizing skills as she prepared her own story proposal, but spent the majority of the "instructional" time collaborating with individuals and groups as they attempted to refine their data gathering and writing skills.

Two weeks later, twenty nine satisfactorily completed story proposals sat on the teacher's desk, ready for inclusion in the students' writing portfolios. The students, however were not willing to see this project end. They requested and obtained class time to hear each of the story proposals. Several of them used their proposals as the basis for the full length short story which they completed voluntarily at home. The word of mouth advertising for the fifth grade project resulted in a sixth grade teacher adapting the project for her students.

Unlike the course, project, and curriculum designs described by Cennamo et al., Wager et al., and the Cognitive Learning Group, the design process described in detail here took only a few hours over a several days to complete. At first, I questioned using a complex visualization process for such small-scale design projects. However, like Cennamo et al.and Wager et al, I observed that the type of process used influenced the type of product created. In this elementary school setting, the teachers' approaches to instructional delivery appeared to change as they participated in the ICD process.

The structured collaborative design effort, though brief and informal, combined with a non-linear process of context design, consistently resulted in instruction which was perceived as more authentic, engaging, collaborative, and stimulating for students and teachers than traditional classroom instruction. Incorporating the two categorization systems - core instructional models and stages of knowledge acquisition - resulted instructional activities in which students evidenced academic growth while producing products of high quality.

Design into Practice in Higher Education

"Art Media Techniques: Computers" is a required course offered in the post-baccalaureate program in Art Education at the university. The offer to teach this course became an opportunity to redesign its content and approach. Most courses do not require learners to encounter content from two seemingly unrelated perspectives, yet the use of computers in visual arts education demands that both instructional uses and creative expression be addressed, often simultaneously. Since the experience of producing art with any media is immediate, authentic, and most often happens in real time (Perkins, 1994) a constructivist approach to using the computer as an art medium seemed pretty straightforward and definitely appropriate for the course. Teaching with and about computer technologies as an instructional medium for other aspects of art education from a constructivist philosophy (such as aesthetics, art history, or art criticism), was a taller order. Yet the field of art education and the larger art world has been dealing with the philosophical struggle between modernism and postmodernism since the earliest emergence of such writings. I held firmly to the idea that if any domain could be taught from a constructivist perspective, the most successful and clearly appropriate domain would be the field of art education.

Working from my experience in instructional design and as an art educator, my approach to the design of this course was to first consider the learners and the level of expertise they might be able to attain in the course. Like Wager and Lebow (1995), I spent time gathering information about the previous offerings of the course and about the students' entry level skills through interviews with other instructors and a few of the students who intended to take my course. Based on this information, I considered what these students needed and expected from a course in art education dealing with computer-based technology as both an instructional medium and an art medium.

From the information I had gathered, I first listed the strengths and constraints within which the course would be designed, much as in a traditional design process. In this case, however, rather than focusing on entry level skills needed to complete predetermined goals, the analysis was focused around Jonassen's three levels of knowledge acquisition within the learning context and their potential interactions with Farnham-Diggory's models of learning. The results of this analysis were:

Strengths
- a wide range of student skill and experience levels in art production
- a wide range of student skill and experience levels with computer technology
- an existing collaborative network among the students enrolled for the course
- availability of adequate computer technology in the classroom (PowerMacs, direct Internet connections, classroom LAN, application software)

Constraints
- short duration (the class met 3.5 hours every day for three weeks)
- limited software availability (unable to get certain site licenses)
- delayed installation of promised peripheral hardware

I determined that the level of student expertise envisioned was actually a range of outcomes that could not necessarily be quantified. For some students, expertise might mean moving from a familiarization level to some level of utilization or integration of computer technologies (Hooper & Rieber, in press; Rieber & Welliver, 1989) in their art making or teaching. For others, expertise might mean that they have lost a fear of using a computer or have discovered a previously unexplored use for computers in art.

Thus, the need for a rich learning context that could address the disparate levels of prior knowledge, and the dual role of computers in art, was apparent. Ultimately, I synthesized the purpose of the course into two emphases:

1. to familiarize students with computer-based technologies as a tool for teaching and learning (instructional media) and
2. to introduce students to (or extend their use of) computer-based technologies as art media.

The three week course was then organized around three computer-based projects, written reactions to three critical issues, peer reviews, and an ongoing expectation of in-class collaborative group work. The following paragraphs sketch the process through which some of these course requirements emerged from the ICD framework, and give examples of how the design functioned during the teaching of the course.

In keeping with the constructivist approach of the ICD framework, declarative and basic procedural instruction for each activity were embedded within the larger context of learning about computer-based technologies as instructional media and art media. For example, manuals for software use were available, but no formal instruction was given from the manuals. Rather, I began the course with an exploration of the software in the form of a studio problem as a basis for using the software as an art medium. Since all of the students were able to produce art works in other media, I could assume a certain level of expertise in art. That is, all of the students were at a rather sophisticated level of expertise through acculturation in the art world. They knew the trends, terminology, much of the theory and philosophies of the domain, as well as certain art production skills. The course was designed to provide opportunities and incentives for each student to transfer that knowledge and to build upon it within the context of the course, using the new medium. The

ICD framework became a useful means of visualizing how learners could move through the learning context at different levels of expertise and experiences.

This process worked very well. In Project 1 (exploring the software), each student began with the same digitized DaVinci image, manipulated it using various tools with a variety of software to produce a final image. During the in-class presentations, images were sent via the in-class network from each presenter's computer to other computer screens in the room. Students were able to ask each other how a particular effect was achieved, as well as dialog about the artistic aspects of the images, which increased their computer skills incrementally, as described in Farnham-Diggory's (1994) model of behavioral learning. Thus, the novice computer user was also the expert artist and budding aesthetician, consistent with the spiral, multi-dimensional nature of the ICD framework.

By project 2, the novice computer users became the advanced learners in a developmental stage. Assumptions and personal theories made during their out of class lab work were challenged (or perturbed, as in Farnham-Diggory's model of developmental learning) by more advanced peers or by guest speakers and demonstrations. The ability to immediately try out the "truth" of their personal theories or those of the challengers, particularly in the art production aspect of the course, afforded a rapid advance through the stages of knowledge acquisition .

The projects and small group activities also sparked heated discussions about issues such as the unique attributes of the computer as an art medium, computer software as mimic of other art media, the ownership and originality of images, gender issues, the political implications of access to technology, and school districts' commitment to emerging technologies.

Since debates in the field of art education are currently focused on multiculturalism, educational reform, critical theory, and whether or not to employ a discipline-based approach; I assumed that these issues would also surface during this class. Therefore, three statements were given at the beginning of the course and students were asked to reflect on the implications of computer-based technologies in the arts within the larger context of art education and the socio-cultural milieu. By the end of each week, students were asked to write a brief reaction paper to that week's statement. Course readings, projects, and guest speakers related to the statements provided the rich context for reflecting on the statements.

By far the best measure and evidence of learning in the course, and the success of the instructional design, were the reaction papers. Early in each week of the course, some element of the reaction statement for that week would be addressed, either through class discussions, activities, or a guest speaker. Challenging discussions often prompted students to reconsider certain of their theories or opinions which, on reflection, proved to be not as sound as they had previously thought. In this rich learning context, students would listen to their classmates, read the course readings, and write their reactions based on experience and reflection. The papers were a delight to read and had much to say about authentic learning and about the acculturation process involved in developing expertise, though I have not yet analyzed their content in any formal sense.

Student course evaluations were also revealing. Some students admitted to a new-found courage to using computers in their own teaching, while others moved toward a more integrated level: the computer was already a part of their working life but they now found it could be easily incorporated into their art production. Others remarked that this was the first time they had attended a course which was based on the assumption that they were responsible for building their own knowledge, and marveled that everyone seemed to "get a lot out of" the experience.

Course content and teaching strategies should always be in a state of change. Next year's course will be based on our refined version of the ICD framework, not because it is a good cookbook, but because the framework is sensitive to changes in the context of learning. Next year's level of expertise may be completely different due to the students' entry level, expectations, or area of focus. Since graduate students will be allowed to take the course for graduate credit, we expect an exciting mix of ideas and abilities, and a real challenge to the usefulness of ICD.

Conclusion

Our concept of Instructional Context Design worked well for us as a framework for developing the learning contexts briefly described above. This visual aid or "graphic" was a useful tool for designing and developing courses within the constructivist philosophy. However, for the framework to have any lasting use for us or for others, we as designers, researchers, and practitioners always need to ask questions that concern the usefulness and relevance of any such design and learning model.

As we reviewed our ICD framework and our experiences using it, we referred to two sets of recommendations which have been proposed for evaluating constructivist instructional design and design models: Dunn's (1994) adaptation of formative evaluation questions first posed by Dick and Carey (1990), and Driscoll's (1994) five conditions for constructivist learning environments. While it is beyond the scope of this paper to discuss how ICD addresses all ten of these recomendations, we will briefly examine a few selected points in the following discussion.

Dunn adapted questions first posed by Dick and Carey (1990) in the context of formative evaluation of instructivist instructional design models. Like Dunn, we believe these questions to be appropriate for evaluating instructional design, regardless of its over-arching philosophy.

Dunn's modified questions for constructivist design are:

1. Are the materials appropriate to the learning outcome?
2. Do the materials include adequate instruction on the subordinate skills?
3. Are the materials clear and readily understood by representative members of the target group?
4. What is the motivational value of the materials? Do learners find the materials relevant to their needs and interests?
5. Can the materials be managed efficiently in the manner mediated?

While the informality of our design process to date leaves us with only subjective evidence, we are comfortable in responding affirmatively to all five questions. Looking back at our design efforts similar to those which Cennamo et al. (1995) characterize as "process-based" (p. 40), we view elements of that spiral process as supporting the attainment of the results called for in Dunn's questions. Instruction in subordinate skills (question #2), for example, is addressed in ICD through the process of design by spiraling back from expert culture (outcomes) to novice-level (entry skills). Insuring the appropriateness of materials to the learning process (question #1), is achieved by repeatedly addressing the three core instructional models in design, and then again in instructional delivery. The remaining questions (3 through 5) are best answered through observation and interviews with learners in a systemic analysis of the application of the design.

We found that our second set of recommendations, Driscoll's five conditions for constructivist learning environments (Driscoll, 1994), fit very well with our concept of designing spiral learning contexts. Cennamo et al. (1995) consciously adapted Driscoll's five conditions specifically to the design process. However, in Instructional Context Design, the learning context and the design context reflect each other. We have found that focusing attention on the learning context and the facilitation of knowledge construction demands a corresponding shift in the design of instruction.

For example, in item two of her five recommendations for conditions of constructivist learning, Driscoll proposes that "social negotiations [become an] integral part of learning" (Driscoll, 1994, p. 365). Cennamo et al. (1995) proposed that social negotiations become "an integral part of designing the materials" (p. 36). In the ICD process, social negotiations are not only employed in the spiral design process, but are also incorporated as a strategy for learning during instruction. Thus in the ICD framework as we envision it, design and application are tightly (if not inextricably) linked, and may not exhibit a clear distinction between (a) design complexity and the complexity of the learning context, (b) social negotiation during design and within the learning context, (c) examination of multiple perspectives during design and within the leaning context, (d) reflexivity during design and during learning, and (e) client-centered design and student-centered instruction (Cennamo et al., 1995: Driscoll, 1994). We maintain that attention to the context of instruction during the design process provides a critical and necessary interdependence between design processes and learning processes.

This is not to say that designing instruction for constructivist contexts lacks structure or identifiable design procedures. Certain steps, or structural elements, are available for the constructivist instructional designer. Rita Richey (1986) noted that most procedural models (as distinct from conceptual or mathematical models) of instructional design "...reflect current and proposed practice. They identify steps, not relationships among variables; their primary function is to facilitate application, rather than to describe and explain events" (p. 94). Such steps or elements of procedural instructional design models serve as a "...source of knowledge upon which theories can be constructed" (p. 94). Richey synthesized several procedural models and identified six core elements of systematic design processes:

1. Determine learner needs
2. Determine goals and objectives
3. Construct assessment procedures
4. Design and/or select delivery approaches
5. Try out the instructional system and
6. Install and maintain the system

In the ICD framework, experience in terms of the focus on learning contexts, provides the conceptual relationship between the "objectivist" design steps and the "constructivist" concern with complex learning contexts, social negotiations, multiple perspectives, reflexivity, and student-centered instruction (Driscoll, 1994). Richey (1986) states that "the credibility of experience as a source of knowledge generation depends on the extent to which these experiences are viewed with objectivity and on how broadly they can be applied" (p.94).

Reflecting on the spiral process involved in ICD, and on the organic and participatory nature of the instruction, we examined our learning contexts in terms of the six elements described by Richey as an attempt to "view with objectivity" the usefulness of the ICD framework. In ICD, the elements, which are evident in most instructional design, do not appear as linear and discrete steps in the process, but rather as parts of recurring cycles, or as elements within the organic whole of the instructional context. Learner needs (core element #1) for example, are identified at each stage of the process of tracing back from expert to novice during the design spiral. They are one of the important issues encountered at each level of that analysis. Later during the instruction, as learners move through the instructional context, their needs come into play in the interaction of prior knowledge, instructional models, and levels of learning.

While we conceptualize these steps in ICD as dynamic and continuous stages as learners spiral through the learning context, we agree that it can be useful to consider the stages and levels as if they are discrete entities. From a micro, or analytic, perspective, such consideration can serve as a microscope for identifying the specific instructional components involved in designing a course, lesson, or instructional system. From a macro, or systemic, perspective, the levels and stages can be helpful in providing a broad telescopic view of the complex constellation of elements comprising the whole of an instructional endeavor (Salomon, 1991). We believe this approach to design and instruction results in an emphasis on process rather than steps or procedures, but still addresses the questions and critical issues raised by Dunn, Driscoll, Richey, and others.

Both of our design examples are small and were first time attempts to consciously design from a constructivist perspective. Our materials were never intended for mass production for off-the-shelf curriculum building. However, we will most likely use much of what we have designed and presented here in future courses. We believe that both attempts exhibit sound instructional design qualities, planning, and procedures. We hope that the process described here will aid designers and instructors in their efforts to develop effective means for approaching their tasks from a constructivist perspective.

We have concluded that attention to the context of learning and to how that context facilitates learning, is the "value added" by adopting a constructivist epistemology in instructional design. We do not advocate abandoning concern for the delivery system or the course content, but believe that a visual or graphic framework such as Instructional Context Design may help us avoid approaching instruction and design as if media, method, and application of the design are separate entities.

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Title:

Six stages for learning to use technology

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ABSTRACT

Learning to use technology for adults can be traumatic. This paper describes six stages adults may go through as they learn to use technology to communicate electronically.

An action research model has been used to develop a strategy for adult learners to understand the stages they will go through as they learn to use electronic mail as a communication tool. There are two cycles in the study reported in this paper. First, is the identification and description of six stages learners go through asthe technology moves from being intrusive to becoming invisible. And secondly, is the application of metacognitive understanding of these stages by new naive adults learners as they use the technology.

When new technology learners apply the knowledge of these six stages to their learning, they appreciate they are not unique and inadequate in their ability to come to terms with the technology. In addition,teachers of technology who have knowledge of the six stages can identify the key times when they need toprovide intensive support with the knowledge thatthe learner will require less support during the later stages.

INTRODUCTION

Access to technology can "allow people separated by distance and time to occupy a shared synthetic world, where they can collaborate to evolved common virtual experiences" (Dede in O'Neil, 1995, p.11). In order for educators to keep up with, and to be actively involved in, national and international trends, it is an advantage to have the ability to communicate with colleagues across the globe. However, in the information age where the Internet may be a way of life for the young child, many adults find learning to use computer technology is very daunting. Adults who are not familiar with technology can feel left behind. Special attention needs to be given to ensure they learn without loosing self-esteem andwithout dropping out all together. Simonson, Maurer, Montag-Rorardi, & Whitaker, (1987) identified 'that a positive, anxiety free attitude toward computing was a necessary prerequisite of computer literacy' (p.233).

Researchers (Rosen, Sears,& Weil, 1993; McInerney, McInerney, & Sinclair, (1994) studied university students' levels of computer anxiety before and after taking computer courses. The type of computer course has been an important factor in reducing anxiety (Leso & Peck, 1992). However, reducing anxiety through learning computer applications using a relevant activity combined with an understanding of stages a learner typically goes through during the learning process has not been considered. Learning in this context represents the new understanding and skills which occur when technology hardware and the software processes move from being intrusive and frustrating to being invisible. This allows an individual to develop confidence and consider creative uses of the technology.

The study reported in this paper is qualitative and based on personal e-mail diaries written by adult learners. It focuses on the identification of learning stages in these students self-reports as they use e-mail for first time. The second phase of the study involved introducing the identified stages to a new group of students also learning to use e-mail.

Computer Anxiety

In the information age adults believe they should be computer literate. Many feel inadequate about their abilities to develop computer skills and actively avoid using computers. Evans-Andris (1995) observed elementary teachers and found:

> Approximately, 62% of the teachers tended to engage primarily in distancing routines, limiting their involvement with computers, whereas approximately 38% of the teachers engaged primarily in embracing routines, increasing their opportunities to use the equipment. (p. 20)

Kolehmainen (1992) suggested computer anxiety will have negative effects when learning new technology because of a resistance to change. If this is so, it may be important to identify for learners a relevant purpose for learning which reflects and reinforces their current values. Involving students in a relevant task where the technological processes are merely a means to an end, may lead to overcoming computer anxiety earlier.

Rosen et al. (1993) and McInerney et al. (1994) found first-year university students in the 1990s to be computer anxious as they commence their compulsory computer studies. Both these studies reported many of the students still remained anxious at the completion of their computer course.

A computer literacy and computer anxiety test has been devised by Simonson et al. (1987) and has been used to measure the level of computer anxiety in university students before and after completing a computer course.

The type of computer course can have some influence on the level of anxiety of graduating students. Leso and Peck (1992) found students taking a software tool course (included word processing, spreadsheets, etc.) were more likely to come out with reduced anxiety than those students doing a programming course. However, the study did not explore the reason for this outcome. In fact, many students did not reduce their level of anxiety by the end of either course.

"Increased computer experience does not necessarily alleviate anxiety" is also reported by McInerney et al. (1994. p. 47). These authors suggested researchers focus "on building confidence and a sense of personal control in a non-threatening learning environment, individualized if necessary" (1994. p.47). It appears the processes of learning to use computers can cause a decrease in self-esteem.

Becoming Computer Literate

Being computer literate implies being able to use a computer and to apply current understanding to new situations. In relation to this paper, computer literacy refers to common hardware and software 'tools' programs and, in particular, using e-mail. In early computer experiences the hardware and software are intrusive. As the learner understands how to manipulate the computer, more control over the technology enables the focus to shift to tasks to be completed.

Valdez (1989) suggested that "technology should be the means by which teachers and students are able to feel more empowered and in control of their lives" (p. 38). He identified awareness, adoption and refinement/adaptation as "three stages that most people experience when learning to use technology" (p.37). The present study reports finding six stages which learners go through as the hardware and software processes move from intrusive to invisible.

Learning to use technology in this paper is presented from a constructivist perspective where learning occurs through immersing the learner in a real and relevant experience with collaborative faculty and peer support. The learner brings metacognitive understanding to the learning situation to help overcome some of the frustrations of learning and bring understanding to the task.

The learner constructs personal meaning through immersion in the situation and develops strategies for building an understanding of the practicalities of the technological processes. Apart from the physical presence of the technology there are other sources for help which range from printed manuals to faculty and peer support. The learner develops an understanding of how the technology operates and identifies the steps required to make it work in order to achieve success in the processes. The understanding will be such that the learner can accommodate flexibly when varied processes are required.

In the study reported here the students were given operation manuals, personal instruction, provided with faculty and peer support, but were encouraged to create their own mental schema and processes to understand the technology. This is carried out through the immersion in a real and relevant task which involves children from schools across Australia.

THE STUDY

Initially thirty teachers studying in a post-graduate university course were involved in a compulsory assignment which required them to learn to use e-mail. The vehicle for their learning was to take the role of a character from a children's fiction book and respond to letters from school children. This Characters-on Line Project during a three week period provided a service to Australian schools (Russell, in press). All communications took place using e-mail. In addition to e-mailing to the children, each student was required to send three e-mail message to their professor explaining how they were learning to use the technology. These messages, or metacognitive learning diaries, were sent at intervals throughout the learning experience.

Students came into the course with varying technological knowledge. While some had actively avoided using computers, others had practical experience in word-processing and school library automation activities. No student had previously accessed electronic mail.

Initially all students were on-campus attending university full-time. Over the following years the nature of the course changed and the majority of the post-graduate students became part-time external or open learning students, many of whom live in remote locations. They accessed e-mail and completed the project assignment with a borrowed modem from their home or at their local school.

Since the initial thirty teachers completed their e-mail assignment, some 400 students have repeated the process and e-mailed metacognitive reflections on their learning experiences. The e-mailed metacognitive reflections from students formed a pool of data which was analysed using grounded theory (Lincoln & Guba, 1985). Categories of metacognitive reflections on the experience of learning technological skills related to using electronic mail were identified. Six categories emerged from the diary reports and these formed stages which learners typically go through as they learn to use technology:

Stage 1: Awareness
Stage 2: Learning the process
Stage 3: Understanding and application of the process
Stage 4: Familiarity and confidence
Stage 5: Adaptation to other contexts
Stage 6: Creative application to new contexts.

In the second stage of the study these six stages were presented to new students as they commenced their email experience and learned to use the technology. These students were asked to reflect on their personal learning in relation to the identified six stages. This second aspect of the action research cycle validates the six stages as students reported similar feelings of frustration and success. This aspect will be explored after describing in more detail the six stages for learning to use technology.

PHASE ONE: STAGES FOR LEARNING TO USE TECHNOLOGY

The six stages learners usually pass through as e-mail technology moves from the intrusive to the invisible are described and supported by illustrations from metacognitive reports of the students.

Stage 1: Awareness

Here students are aware that electronic mail exists. Many students have actively avoided using computers and no student reported using e-mail prior to this compulsory activity. A sense of nervousness and fear was in the minds of some students while others were looking forward to having the opportunity to do something they had heard about.

I had no idea what was actually going to occur. I had heard of electronic mail, but had never seen it in operation. Because of this, I felt rather bewildered and to a certain extent concerned.

The very thought of such technology - computers, satellites, etc., was extremely daunting. I was also excited by the idea that I would have to be involved and get to know all about it.

Stage 2: Learning the Process

Reports of time-consuming assimilation of new information as new skills are mastered epitomizes this stage. Instructions are often misleading for the novice who does not understand the processes. Frustrations with complex technology renders the equipment intrusive in the eyes of the user. The technology can overpower and intimidate the learner.

Some students without extensive computer experiences, are afraid of damaging equipment. Others, in hindsight enjoy this challenge and persevere to ably move beyond this stage. Most students find working within a group is extremely valuable for providing moral support. Apart from peer support, this stage requires extensive technical and positive encouragement from the teacher.

We experienced a variety of emotions: extreme frustration often when there appeared to be no logical explanation for things going wrong; annoyance about the amount of time wasted.

The handbooks were meaningless, until I had some 'hands-on' experience.

Those experiencing problems only had to ask and someone was sure to be there with a suggestion or hint.

Stage 3: Understanding and Application of the Process

As the learner begins to understand the logic behind the technological processes, the need to cling to step by-step instructions can be relaxed. Where early instructions had no meaning and were therefore forgotten, now the learners have 'hands-on' experience and they can accommodate new instructions within their basic understanding. The relevance of the task gives added incentive with a purpose to continue learning the processes. A sense of community is felt with the presence of peers who are also learning the processes and providing moral support.

After plodding through a couple of weeks, our knowledge of [e-mail] had increased and so, this time, some of the things began to makes sense, and suddenly we could see where we had gone wrong. The next attempt brought success!

Stage 4: Familiarity and Confidence

With confidence the technological processes are applied to the task at hand as the learner can visualize the processes and anticipate logical outcomes for certain software commands or apparent inconsistencies. The technology is starting to become transparent when problems become 'hiccups' rather than major distracters.

Sometimes there is a reversion to earlier stages, but confidence is more quickly regained. Self-esteem is increased as the learner is able to solve the problems through familiarity or logical analysis of the situation. Working things out alone give a sense of knowing, understanding and confidence.

By the beginning of the second week I could successfully work on [e-mail] without the use of the much valued manual - something I was quite proud of.

Having overcome the problems of operating the system efficiently, I could then concentrate on the process of the task: assuming the role of the character of Wilbur. This was one of the highlights. Being able to communicate with children and sharing with them their thoughts and feelings on the book " Charlotte's Web".

Stage 5: Adaptation to Other Contexts

Now the technology and software are invisible and the learner can see the potential for use of e-mail in other curriculum situations. New understandings and experiences are transferred to other contexts. For example, one student reports a new sense of confidence when she assists school children as they learn a word processing package she has not previously seen.

Now that I know how to operate the system, I hope that I will have the opportunity to work on future email] projects. As well, this time has also made it evident to me that I will need to become more familiar with computers and associated pieces of equipment, if I am going to incorporate them successfully into my resource centre.

Stage 6: Creative Application to New Contexts.

This stage is reached by students for whom the technological processes become invisible and who naturally use electronic mail to extend their educational environment when this is appropriate.

Several years after this initial contact with e-mail, some students have reported that the experience led themto become the computer coordinator in their school. Other students have sent future assignments via e-mail when this was not an expectation. Recognizing implications and possibilities for other uses of e-mail was also evident.

Electronic mail could provide deaf children with the facility to participate in the visual form of natural language with their peers. It would also widen the audience for outback students.

PHASE TWO: METACOGNITIVE APPLICATION OF THE STAGES

Once the six stages most students go through as they learn to use the technology were identified, new students were introduced to the stages at the beginning of their on-line assignment. The diary reports they send reflected their personal learning in relation to the six stages. The intention was to provide the opportunity for the students to articulate their personal learning strategies and also to validate the six stages as being applicable for learners of new technology.

My reflection on their metacognitive insights helped me to identify how better to assist these and future students as they learn new technological processes.

The following discussion epitomizes e-mail diaries of sixty students doing the Characters-on-Line Project in 1995. It should be acknowledged that some students may not like to admit their feelings of inadequacy. However there are sufficient positive reflections to indicate students' computer anxiety is overcome at the completion of the task and confirmation of the six stages for learning to use new technology.

A case study of Pat will be presented here with her references to the six stages as she was learning to use e-mail. Her insights were typical of the other students. The following message was sent to me six weeks after afive hour introduction and hands on training session during an on-campus session at the university. Pat is a full-time teacher-librarian (media specialist) living in a country town too far to return to the university for assistance in using e-mail. She was a member of the team who were took on the character of eight year old Jason from a picture book called Our Excursion by Kate Walker & David Cox (Omnibus Books). As "Jason", Pat replied to letters from school children across Australia.

Stage 1: Awareness

All my initial fears, phobias and woes seem long forgotten and I'm a bit sad to be saying good-bye to Jason and the [e-mail] kids. I jotted down a few notes regarding the six stages you propose. In Stage 1 I certainly had mixed feelings about what was going to occur. The best way to describe it I guess is that it was a strange mix of excitement and terror - do you know that feeling?

As I read the comments from students, I am conscious of their anxiety at the beginning of the project. Many have avoided using computers and others are afraid of the technology and the damage they will do to the hardware. These students need to have useful instructions, equipment that works andaccess to someone who knows the particulars of their computer setup. At the same time there are students who are confident and keen to extend their experiences with the technology.

Stage 2: Learning the process

I felt fairly confident when I left uni (how those other students managed with a phone workshop I'll never know - I guess I'm a hands on learner), but when I got home I had trouble setting up the system and our shared phone line crashed for a few day. It threw me and I lost confidence. In Stage 2 I was pretty much frustrated and impatient. I felt uncertain and suddenly all the instructions that had seemed clear at uni didn't seem to make sense.

Stage Two requires direct non-threatening assistance from someone who has knowledge of the student's individual computer setup. Preferably this is someone who is readily available on site or via telephone. It is this stage where I receive many phone calls for assistance. Observation of two naive learners sitting together at one keyboard is fascinating. The person at the keyboard seems to have an empty mind and the observer knows all the answers and steps in the process. They then exchange positions and the empty minded person has all the answers as the former expert sits at the keyboard with an empty mind!

This stage requires confidence building. It is essential students do not feel or be made to feel stupid. A phrase I use often during this stage is, "The more mistakes you make the more you will learn." Permission and even encouragement to make mistakes is essential and acknowledges that others are equally unaware.

Stage 3: Understanding and Application of the Process

Stage 3 was reassuring because gradually things started to fall into place. Although I felt that I didn't know where my information was at any one time (cyberspace???? what is that ???) I gradually was coming to grips with the [e-mail] concept. I learned the hard way to be accurate.

Less help is required from experts at this stage. Often students turn to each other via e-mail or telephone for assistance. They build confidence as they help each other overcome problems. My presence is seldom sought.

Stage 4: Familiarity and Confidence

Stage 4 was great. I was up and rolling and really having fun. I was in character with Jason and starting to develop a fondness for him. I enjoyed getting the kid's letters and even wrote to a couple and asked them to write back to me and tell me their dog's name etc. One letter was quite sad, about a recently deceased pet dog, and I felt Jason could identify with how he would feel if his dog died and maybe in some small way help the grieving of that child --Who knows? I enjoyed the freedom of the character and talking in an eight year-old way to the kids - don't show this to any psychiatry colleagues!

Even the way this is written reflects the freedom experienced when the technology begins to turn invisible and the task becomes the focus of attention. Letters I receive at this stage are longer and the students talk about their family and leisure time pursuits in addition to their involvement in the task.

Stage 5: Adaptation to other contexts

Stage 5 - I started to think about how I could use [e-mail] in my job -perhaps to contact authors etc. I can see that it will be possible to use [e-mail] to communicate with other teacher-librarians etc. Is there a directory of users available ?

Here Pat is moving beyond the immediate task and exploring the potential for relevant use of e-mail in other aspects of her job as a media specialist in a school. By now the technology is invisible and only a vehicle through which the wider world can be reached for personal professional development and for the benefit of student learning.

Stage 6: Creative Application to New Contexts

(Stage 6).
Thanks for the opportunity to [e-mail] I have enjoyed it and it has given me a common experience to share with my student colleagues in the oft' lonely land of external study. Cheers, Pat.

Being a member of an e-mail team has had a side benefit where colleagues have been brought together and shared problems and so come to know each other. In the future they may continue to be in touch through e-mail and so a network of professional communication has commenced.

Pat can not reflect on Stage Six yet as, by its very nature, it will not be evident until some time after this project is ended. Then Pat may find she wants to achieve a particular vision and e-mail will be the most obvious way to achieve it. During the semester I have received requests for extensions and clarification related to assignments for other courses from students who were originally introduced to e-mail as a Character-on-Line.

While many students reported concluding the project with positive computer learning and less anxiety, no formal measure of computer anxiety either pre or post project was administered. Some students chose not to write about their learning in relation to the six stages. No close record was kept of students who claimed to be anxious at the beginning and their outcome comments at the end. As with many e-mail messages the request for information is often not responded to. It could be possible that students not reporting their computer experiences were either still anxious or the technology was so invisible they did not consider reporting to be of any consequence.

CONCLUSION

The six stages of learning to use a new technology has been validated through this study. The students seem to jump the hurdle of the computer anxiety in order to put their minds to the authentic task of being a character in a book and writing letters to real students in schools across Australia.

This empirical study is as applicable for teachers of computer anxious learners as it is for the learners themselves. Four recommendations are suggested for instructional designers of courses for naive computer users:

1. Use a novel relevant real-life task to encourage the student to jump the hurdle of the processes in order to become involved in the task. Leso and Peck (1992) found students learning word-processing and other tool skills likely to be less computer anxious at the end of the course. However, they still found a third of these students measured high on the computer anxiety scale. Perhaps a pre and post computer anxiety measurement where the course included a novel and relevant or authentic task as an outcome would find a lower number of computer anxious students at the completion of the task.

2. Introduce the six stages for learning a new technology to students before they commence a computer course. Frequently students report feeling inadequate and stupid and expect to be experts with their first computer experiences. Through knowing the stages they may relate to the frustrations of previous students and remove some of the pressure to be perfect at the first attempt. Knowledge that they will eventually succeed as other students have done can remove some of the stress.

3. Provide a non-threatening environment with extensive technical and moral support during Stages Two and Three when self-esteem can be low and problems are not easily solved by a naive learner. McInerney et al. (1994) suggested students develop confidence if the learning environment is non-threatening. At this time there is a need for mediation and coaching. It is preferable for a non-threatening expert to be readily available on site, but, if this is not possible, telephone contact with the teacher or another expert is appropriate. However, when students are unable to contact an expert they find solace and problems are solved through talking or e-mailing with a student colleague who is learning the same processes. It seems a learning community can be developed which builds confidence and understanding in all members of that group. This idea parallels Dede's suggestion (in O'Neil, 1995) of students sharing a 'synthetic world'.

4. Encourage students to articulate their metacognitive experiences in relation to the six Stages. When students verbalize their learning, they can identify where they have come from, where they are now and the vision of success. The act of interacting with the six stages in order to clarify their own learning situation objectifies their learning and may remove negative subjective thoughts.

In the future the technological processes may not be electronic mail, but another technological innovation which needs learning through coaching and support with frustrating and time consuming focus on the processes before the technology invisibly becomes incorporated within an environment. Only then can creative and worthwhile uses be applied in a variety of contexts.

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Title:

Affordances and Constraints of the Internet for Learning and Instruction

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Abstract

The Internet promises dramatic changes in the way we learn and teach, the way we interact as a society. The changes of a coming epoch are already taking shape. In higher education, most students have access to Internet resources. But many who have access have shown reluctance to make use of those resources. An attempt to understand this reluctance has led to an analysis using James Gibson's model of affordances. This paper contrasts the Internet with other fundamental educational infrastructures throughout history. It offers an analysis of literacy, printing and electronic publishing in terms of human affordances along with the constraints associated with each medium.

Affordances and Constraints of the Internet

The history of Education cannot be told apart from its technology. From orality to literacy, from manuscripts to the printed page, from text to hypertext, the prevailing technologies supporting education have defined its very nature. Stopping short of technological determinism, we acknowledge the chicken-and-egg relationship between technology, education, and society. The possibilities which education brings to society depend upon the affordances of the undergirding technology.

We use the term affordance to describe a potential for action, the perceived capacity of an object to enable the assertive will of the actor. The term was coined by psychologist James Gibson (1977) to describe the action possibilities posed by objects in the real world. There are many objects in our environment. Some we ignore, some we adapt to, and some we appropriate for our assertive will. It is the objects in this last category which fall under the the definition of affordances. Certain objects afford opportunities for action. An affordance is a value-rich ecological object that is understood by direct perception. Perception informs the individual of affordances. Action transforms affordances into effectivities which extend human capabilities (Allen and Otto, 1995). Our own bodies are affordances. The eyes afford perception, the ears listening, the hands manipulation, the tongue and vocal cords afford utterances (Jonassen, Campbell and Davidson, 1994). Natural affordances emerge into effectivities through use in conscious activity. The hand of an infant, though attached, is a separate object. The infant is amused by it, studies it, tastes it, touches other things with it. Soon the infant learns to use the hand to manipulate other objects. In the process, the hand gradually transforms its object-ness to subject-ness. The child becomes less conscious of the hand as she uses it as an extension of her own intentioned will. The affordance becomes an effectivity.

Technology and media are affordances to the extent that they promise extended human capabilities of seeing, hearing, and uttering. Tools are affordances to the extent they offer extended human capabilities for manipulating things in the environment. (Rasmussen, et. al., 1994). Through use, skill is acquired and the object becomes an extension of ourselves (McCluhan, 1964). These artifacts are transformed from affordances to effectivities.

Literacy

Five thousand years ago the affordances of orality and rhetoric were extended by the technology of written text. Writing enabled the precision of recorded memory. It afforded cognitive communication across time and distance. Literacy gave birth to History. The written word introduced constraints of grammar and syntax, but out of these constraints emerged stability and permanence of language. It was a means of representing and archiving human knowledge for later retrieval by one's self or by another.

We look at antiquity through the eyes of those who could read and write, shading, perhaps, our view of the importance of literacy in shaping history. When we think of antiquity, Athens invariably comes to mind. Athens was among the few ancient cultures that valued literacy. Athens provided a system of public education which included reading and writing, an affordance we take for granted today. But, just as it is today, not all Athenians chose to appropriate skills of literacy. Athens produced history's most famous illiterate, Socrates, who opposed the technology of writing on the grounds that it would corrupt the human mind and destroy the memory of mankind (Plato, 360 BCE). We suggest, from the standpoint of affordance, that Socrates perceived no need to write. After all, he had his graduate students, Xenophon and Plato, to record his words for him(1). But more fundamentally the assertive will of Socrates found its full potential within the affordance of oral discourse and dialog. Writing, to Socrates, was an aimless diversion. Indeed, for most of written history, writing was not an affordance for the common person. For centuries, it was the exclusive realm of the power elite.

The manuscript was an instrument of power. The written word is a permanent record, an objective archive, a sense of authority. Manuscripts were guarded, protected and generally inaccessible (Mukerji and Jones, 1995). For thousands of years, written knowledge was the affordance of the literate few: the priests and princes who controlled access to manuscripts and who had the skills to make use of the technology. Those who controlled knowledge controlled the collective conscience, the laws, the social structures, and the tax records. Literacy was the means of social control.

Medieval to Modern

In the period approaching the late Middle Ages, the power of literacy began to spread to the merchant class. Universities emerged in the thirteenth century, before the age of Gutenberg. Manuscripts were extremely costly, reproduction of a single copy required weeks of labor by an established member of the literati (Eisenstein, 1983). Often, students copied their own texts, transcribing oral recitations by a lecturer/reader(2). Learning to read and write was the privilege of an elite few. For those without means, a literate education was characterized by extreme effort supported only by primitive techniques and rudimentary tools(3). Entry into the literate community was not possible without great personal sacrifice (Cantor, 1969). Manuscripts, the objects that enabled this intention, were affordances for acquiring literacy.

The rise of the universities in Europe and the neo-classicism associated with the return of the Crusaders in the thirteenth century drove unprecedented demands on manuscript production. In a previous era, this renaissance would die before it began, lacking the infrastructure to support the propagation of knowledge. But modern technology was on the horizon. The mid fifteenth century saw the convergence of several unrelated developments: the wine press, paper production, oil-based ink, block printing, and finally, movable type. (Mukerji and Jones, 1995). On a spring morning in 1452, the headlines declared, "The Scribe is Dead. Long Live the Printer!" Print technology was soon to become the affordance of an aspiring middle class.

The modern age arrived with the first edition of Gutenberg's Bible. The cost of book production fell by several hundred fold. A printer could reproduce a thousand copies of a book in the time it took a scribe to reproduce four copies of the same text. Within a few years there were more circulated copies of Scripture and the major classics than had existed previously for all time. In the coming years, the Scriptures and the classics became affordances, not for spiritual ends, but as a means of learning how to read and write, as a means of mastering reason, logic and rhetoric (McCluhan, 1962). By 1501, there were a thousand print shops throughout Europe. They had produced two million copies of texts, 35,000 titles (Mukerji and Jones, 1995).

The affordance of archived knowledge burst free from the constrictive grip of monks, priests and courtiers. The power of print technology was in the hands of an emerging ruling class. The printing press was an affordance for Martin Luther to assert his Ninety-five Theses, challenging established authority. The emerging years brought the Reformation, the Enlightenment and democracy. The bourgeois state triumphed over monarchies. Liberalism instituted basic rights and freedoms: The rights of private property, freedom of self-expression, and freedom of the press. These "self-evident" rights spread throughout the Western world. They were the expressed freedoms for all citizens, but they were particular effectivities for those who owned property, those who possessed the skills associated with self expression, and those who owned or controlled the presses (Bagdikian, 1993).

The modern age became an age of reading and writing (mostly reading). Book learning changed the nature of basic education throughout the West. The providers of education (initially the church, and ultimately the state) perceived it as an institutional affordance to foster morality, patriotism and citizenship. Education itself was primarily moral (the intention of the institution) and secondarily intellectual (the intention of the learner). Educational technologies (the textbooks, the lessons, the methods) were designed to carry out the primary intention. The Massachusetts law of 1647 made its intentions explicit: to disable the "project of that old deluder Satan to keep men from the knowledge of the Scriptures" (Massachusetts School Law, 1647). Doctrinal intentions prevailed for over two hundred years in American Schools. Instructional technology reflected those intentions. The hornbook was designed to teach basic reading, but more importantly, Christian doctrine. This technology was a wooden frame on a handle. The frame enclosed a single printed page containing the English alphabet followed by the text of the Lord's Prayer. The New England Primer was

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characterized by heavy religious platitudes: "In Adam's Fall We sinned all." "The idle Fool Is whipt at School," etc.. Noah Webster's Blueback Speller offered short parables with morals explicitly interpreted on each page. From 1836 to 1907 the McGuffy Readers set the standard for American grammar school education. There is rarely a page in that series of six readers which does not address itself to some moral problem from the standpoint of Protestant Christianity and Victorian ethics. The six books propagated a middle-class, conventional, paternalistic morality, reflecting the values of the dominant culture (Commanger, H.S., 1962). Education molded the collective conscience. Literacy was a means for social control.

Education in the twentieth century retains a content-centered paradigm of institutional affordance (Lemke, 1994). However, this has been a century of major curricular reforms. The changes have reflected a more diverse and complex society with a broader range of values and priorities. As our society continues to diversify, as the need for technical skill increases, as the world changes faster than textbooks and lesson plans can keep pace, the emphasis on curriculum content is giving way to a focus on the learning process. Constructivism, considered radicalism a decade ago, is the dominant perspective at most educational conferences. Content objectives are giving way to a focus on skills development, instructional designs are giving way to learning environments where students define the central tasks, including how the learning should be monitored, assessed and adjusted to achieve the desired outcomes. Such strategies bring flexibility to the educational process, adjusting to continued change in a postmodern world.

Modern to Postmodern

The term postmodern is often over-used and ill-defined. But we can't come up with a better term to describe the transitions taking place today in educational technology. What's the difference between modern and postmodern? A telling illustration comes from Alluquere Rosanne Stone (1995). Stone describes an encounter between former quiz kid Charles Van Doren and computer interface creator, Brenda Laurel. The encounter took place at Atari Labs in the late 1980s where Dr. Laurel was engaged in research on interactivity. Van Doren was working for the Encyclopedia Britannica company which had begun work on a new interactive version on CD ROM. Stone describes the story:

> He came by Laurel's new office in the lab one day and proceeded to chat her up about interactivity. Laurel's ears perked up. "That's great," she said, "I'm working on interactivity too."
>
> "You are?" Van Doren said.
>
> "Sure," Laurel said enthusiastically. "I've got this idea for an interactive educational thing about whales told from multiple perspectives - whales from an Inuit perspective and then whales from a whaling corporation perspective, and a Greenpeace perspective, say. Multiple narrative thread, user selectable. It'd fit right into your interactive encyclopedia."
>
> Van Doren turned red and began to make a peculiar noise. After a few seconds laurel realized he was sputtering. Finally he burst into speech. "Encyclopedias don't present viewpoints," he said, biting off the words. "Encyclopedias present truth."

This encounter is a vivid contrast between modern and postmodern thinking. The modernist presents the truth, just as it was nailed on the door at the church of Wittenburg in 1557; just as it was introduced to American children in six complete volumes for most of the 19th Century, just as it was represented on the 1950s television quiz show "the 64,000 Question". The postmodernist offers multiple perspectives from a complex world, including, perhaps, the modernist conception of truth (Wilson, 1994).

Today's information technology enables the transition from modern to postmodern, no less than the printing press enabled the transition from pre-modern. How many days would it take a scribe to provide us with a copy of Aristotle's Rhetoric? Seven days? Fifteen days? Thirty days? And what is the cost of skilled labor? $10/hr? $15/hr? $25/hr? At the most conservative estimate, the manuscript would cost more than $500. But the modern printing press makes it available for less than $10. And postmodern electronic publishing provides it at virtually no cost! Our computer in Denver is connected via the Internet to a computer at Virginia Tech, where the complete works of Aristotle reside on a rotating magnetic disk. We can download Rhetoric instantly, at no charge.

But is it really free? There must be a cost associated.

There is a cost associated with disk data storage. With current technology, the cost is about fifty cents per megabyte. To store Aristotle's Rhetoric (400 KB), the cost is about twenty cents.

At such a bargain, why don't I store it on my own disk? The answer is, I don't need to. I can get it anytime I want from Virginia Tech (or one of the forty some other Internet sites that have it!) What's more, I can link it (as we have done above) to my own writing. To the extent that such capability serves our intended purpose, the link is an affordance for us, the authors. To the extent that the link serves the reader's intentions (regardless of our intentions), the link is an affordance for the reader.

Our point is that technology has changed the way we consider content. In a 14th century university classroom, a manuscript of Rhetoric was likely the exclusive source of information. That was a constraint imposed by the technology. Today, we can download Rhetoric in seconds, but we can also download related texts, commentaries, research studies, historical perspectives, ad infinitum. We can scan these texts with the eye of a computer, discovering patterns, linking them to allied texts, offering multiple dimensions of textual analysis (Olsen, 1993) (Landow, 1994).

Interactivity

In recent years, a prime objective in media development has been the quality of interactivity. This has been especially true with educational media, starting in the 1950s with Skinner's "teaching machine", evolving in the '70s to "response-and-branch" CBT, progressing into the '80s with Apple's "poke-and-see" hypercard and ultimately, "answer-vision", the hopes behind interactive video. All of these are examples of closed systems in which the content is pre-defined, responses are anticipated, and action is controlled by the designer alone. Interactive video pioneer, Andy Lippmann, lamented the inherent weakness of such closed systems. None seemed to satisfy his definition of interactivity, the mutual, autonomous, and simultaneous activity of both participants working toward a common goal. Lippman suggested five criteria which are necessary to satisfy this definition: (Brand, 1987) (Stone, 1995)

* interruptability, the ability of either participant to interrupt the other at any point.
* graceful degradation, the ability to set aside the unanswerable questions in a way that does not halt the conversation.
* limited look-ahead, the quality that makes it impossible to predict the ultimate outcome of a conversation by either party.
* no default, a quality which allows the shape of a conversation to develop naturally, organically, without a preplanned path.
* the impression of an infinite database, the quality of limitless choices and realistic responses to any possible input.

Lippman's criteria are fundamentally unreachable under the constraints of a closed technology. But the open architecture of the Internet transfers interactivity from an affordance of designer control to that of user control. From flat textual domains to full motion video, the Internet transforms the mechanistic character of modern media into a postmodern phenomenon, shifting agency from author to user. The designer has lost control (Kelly, 1995), but the medium has gained credibility. We no longer have to contrive interactive "lessons" and exercises. The real world is waiting on the other side of the terminal.

When we speak of affordances in the study of media, we are cautioned as designers to resist the assumption that a given medium affords a specific set of learning outcomes. In reality, learning is distributed between the medium, the learner and the context (Jonassen, Campbell & Davidson, 1994). There is nothing inherent in the Internet that guarantees learning.

But in a specific context involving learning activities, such as research, collaboration, self expression, and reflection, the Internet offers multiple affordances, so numerous that it may be a mistake for us to treat it as a medium. It is really an infrastructure which brings together media, tools, people, places and information, expanding the range of human capabilities.

If we treat the Internet as an infrastructure, then we can draw comparisons between the Internet and other infrastructures which society has come to rely upon for learning and education. These include:

- a library
- a publishing house
- a school
- a community
- a city
- (please add to this list)

We suggest that the Internet offers multiple affordances, not unlike other infrastructures for learning. And we suggest that the Internet overcomes significant factors which have historically constrained the others. A comparative analysis may illustrate our point.

Library

The library is an infrastructure containing multiple technologies working together to deliver specific information in response to an inquiry. The patron consults a data base (card catalog or electronic index) to find a range of books which may contain the desired information. The patron selects the most appropriate listings from among those suggested, then proceeds to the locations in the library directed by each selection. For each book that is located, the patron consults its index and table of contents, then leafs though the pages to confirm whether the book holds pertinent information. If so, the information is eventually extracted and the task is complete.

Research on the Internet involves a similar process. The user consults a database called a search engine. A simple or structured query will yield a set of hits or listings, not unlike the selections from a library catalog. The user selects the most appropriate hits, retrieving each document electronically. Within seconds each target document is retrieved. A hypertext index or table of contents will allow the user to dip into the text wherever her interest leads. For plain text documents, the user can invoke a keyword search utility on her browser locating specific paragraphs of interest. Pertinent information is extracted and the task is complete.

Like a library, the Internet affords great potential for research. The processes of information searching are similar, if not identical. The results are not so similar. At the present time, a good research library is likely to yield a higher quality result than the Internet. But the Internet is likely to yield more up-to-date information than a library.

A comparison of constraints will reveal some important differences:

Schedule

A library is constrained by limited hours of operation. Serious researchers are painfully familiar with the signification of flickering lights toward the end of the library's service day. But the Internet is not constrained by schedule. It is as available as a personal computer and a modem.

Location

A library has a fixed location. Most communities have at least one library but rural communities are especially constrained. The Internet is not constrained by proximity. It is accessible anywhere that electronic communication is possible. Typically the electronic patron accesses Internet resource from home or from the work place.

Holdings

A library's holdings are constrained by past acquisitions and current budgets. Most libraries are able to overcome this constraint by interlibrary loans. The Internet is one huge virtual library whose holdings are growing daily. At the present time, resources on the Internet are fundamentally constrained by copyright. Most books in print are available in book stores or at the library, but they can not be obtained online. This is not a natural constraint of the technology, but the result of lagging proprietary laws associated with prior technologies (Lehman, 1994).

Another constraint, at least for the present, is laborpower: the effort required to migrate public domain literature to electronic substrates. This is a noble effort, motivating thousands of volunteer scribes (see Ryder, 1995), but at this moment the bulk of the world's literature remains somewhere on a dusty shelf.

Accessibility

A library book is accessible within minutes, hours, days or weeks, depending on the book's location and availability. Electronic texts are available instantly. Checked-out and overdue documents are unknown in the virtual library. Research sessions need not be interrupted for lack of immediate access. What's more, instantaneous retrieval enables hypertext (linking between texts) as a research affordance -- something not feasible with conventional print media.

Timeliness of holdings

Libraries receive information once it is published. Published information is usually well written, edited and thoroughly reviewed for accuracy. For most quality books, this process takes several months. New material finds its way to the Internet immediately. Many articles are accessible on the net months before they become published in print form. Authors often post early drafts of their work for purposes of feedback and peer review (Harnad, 1995). (This paper was accessible on the net as this very sentence was being drafted!)

The immediate overriding constraint of the Internet is the fact that few users have learned how to manipulate Internet tools with the same confidence that they can manipulate a library. As the Internet evolves, we can observe the changes before our eyes. In the past two years, the number of text objects on the World Wide Web grew from several thousand to several million. The tools for extracting information showed their limitations as Internet holdings constantly increased. New tools have been laid down over the old, smarter, faster, yielding more astounding results. Tools are evolving in the direction of object-oriented simplicity. But users are hard-pressed to keep up with the changes.

The implications for instruction and performance technology in this context are obvious. Most of us learned how to use the Library when we were in school, and we learned by doing -- doing research. In the process of solving research problems we had the scaffolding of librarians and the coaching of good teachers. We suggest that Internet skills deserve a similar treatment. The power of Internet resources remains latent to those without the skills to use them.

But who are the librarians in this virtual library? Who will provide the scaffolding and coaching for the unskilled researcher? Who will undertake the task of conjoining people and knowledge (Birchall and Randa, 1995)? Who will classify knowledge and information? These tasks don't go away in the virtual environment, but the agency of librarianship shifts from the center to the periphery. The role of virtual librarian is distributed. In the virtual library there is no central keeper of knowledge, only curators of particular views (Kelly, 1995). The role of organizing and classifying knowledge is passed to each user. A user saves and organizes the information that is personally useful. As one's interests and knowledge become specialized, a niche emerges for a specific field of knowledge. The ones who use the information are the ones who will organize and classify that body of knowledge, primarily for personal use but also to serve the virtual community. The intellectual labor invested in research is freely shared on the net as users make public the artifacts of their own knowledge construction: the bookmarks, lists and directories of information we compile for use in our own intellectual efforts. One person's artifact is another's affordance.

In my own work, I maintain a set of bookmarks related to Instructional Technology (see http://www.cudenver.edu/~mryder/itcon.html). While the work is a product of my own research for my own purposes, it can provide scaffolding for others with similar interests. By making public this entailment, I have the benefits of interaction with others who are drawn to the resource because of their own allied modes of inquiry. The ethic of sharing information, including classifications of this nature, is the emerging culture of the net. The motivation is no different than the traditional practice of publishing scholarly work.

Publishing

The publishing infrastructure has been the primary conduit for knowledge in the modern world. It requires capital and considerable labor to disseminate information in published form. Between the modern author and the reader is an infrastructure which includes editors, type setters, printers, binders, and a complex marketing and distribution organization. For a publisher to print anything today, a business case must guarantee proper return on the investment. At a time when society's need for diverse information expands geometrically, the number of corporations which control the publishing infrastructure continues to decline (Bagdikian, 1990). While freedom of the press is extended to all, its affordance is an exclusive privilege.

The concept of free expression is changing as we pass from the modern to the postmodern. Having the right to free expression is something entirely different than having the affordance of expression. Just as technology challenged exclusive control of knowledge in the fifteenth century, exclusive control of information is challenged again today, this time by the Internet. On the Internet, there is no central control: no editorial board to determine acceptability, no screening committee to determine relevance, no financial board to assess marketability. Each author is her own publisher. Each reader, his own editor. All that is required for publication on the World Wide Web is a personal computer, a modem, and a user account on an Internet server. Students and faculty enjoy such affordance at most major universities. Commercial providers offer public access at at costs comparable to telephone rates. Public schools are on the World Wide Web, publishing hypertext productions by teachers and students. Today a third grader has the same affordance for expression as any other netizen, be they politicians, professors or published authors. What's more, her physical youth can be masked by her abilities of expression, making her a virtual equal among adult netizens (Fishman & Pea, 1993).

During the past decade, constructivist researchers have stressed the importance of anchoring instruction to genuine tasks in situated contexts (Cognition and Technology Group at Vanderbilt, 1992)(Brown, Collins, and Duguid,1989)(Resnick, 1987)(Jonassen and Duffy, 1992). The Internet offers countless affordances toward that instructional goal. Consider a seventh grade class learning English grammar, spelling and rhetoric. Consider the World Wide Web as an affordance. Imagine the possibility of our students providing a web page that is a genuine service to the Internet community, something the students care about, and something that is needed. Consider a likely niche, such as a weekly review of children's television, a computer help system for low-tech parents, a FAQ database on snow boarding, roller blading, etc.. Writing for an audience of peers around the world is likely to elicit motivations that go beyond teacher expectations. To the extent that students use the opportunity to present themselves before a world wide audience their writing will be influenced by motivations of ethos, style, and delivery: the elements of classical rhetoric. The constraining factors are likely to include the teacher's comfort level with the technology, and her willingness to yield control of the resource to her students, the level of her perception about the Internet as an affordance for learning goals (not necessarily for other institutional goals).

The affordance of world wide public expression is something new for all of us. With the Internet, the perceived capability of self expression in a world-wide forum can be extended realistically to the common person. However, there is no expectation that each person will embrace it. Consider Socrates' reaction to literacy. Consider the skepticism of most Americans, saturated with the hype of technology and media. By definition, an affordance is the the potential for action. This implies that there is a will toward specific action. Implied in the affordance is the intentional desire for action and the recognition that the object can enable one's intentions(4).

Quality Control

For the reader, a fundamental constraint has to do with the accuracy, veracity and reliability of online information. This is not to say that accurate information can't be found on the net. The implication has more to do with the shifting role of the reader in assessing the accuracy, validity and applicability of materials which were heretofore left to editors, experts and peer professionals (Ryder, 1995), (Eco, 1979), (Landow, 1994), (Kelly, 1995). An additional skill will be essential to our basic education-- the skill of abductive logic (Peirce, 1902) (Shank, 1994). The goal in abductive logic is not ultimate truth. It is the ability to advance one's inquiry. Abductive logic is the logic of signs: the ability to extract meaning from a given set of circumstances and then to adjust one's inquiry as new information unfolds. The skill of Sherlock Holmes is critical skill of the information age.

There are Internet tools to assist in this process. They are called robots or agents. An agent is a software tool that is dispatched to accomplish a specific task. As information continues to abound on the Internet, we will need such tools to assist us in our searches. The standard tools are search engines which accept a set of keywords from a user and return a list of resources in rank order, listing first those which best match the search criteria. The problem is that searching on a single word can yield overwhelming and debilitating results (Eco, 1995). Stone (1995) suggests that the ideal model for an agent is the graduate student. Graduate students are trained to do research. They can assess the usefulness of new information within in the context of the present inquiry. A research assistant is attuned to a professor's work, and is able to gather the kind of information that fits a given research project. Can software agents be designed to fit that model? So-called intelligent search applications are available today. Instead of submitting a simple keyword, phrase or boolean expression, the user can submit a complex object: a bibliography, a list, an index, an article. The intelligent agent discards incidental and common words from the text object, prioritizes the remaining words by the frequency of use. Multiple searches ensue, and results are evaluated against the model object. Tools of this nature produce quality results for minimal time investment, overcoming the debilitating constraints of too much information associated with simple searches.

The fundamental characteristic of the Internet is that it cannot be controlled. While local legislation can influence pockets of control, the Internet is a world wide phenomenon, with no one in charge, (with everyone in charge). The Internet is not the McGuffy Reader. In more modern times educators could easily control what their students read and direct how those tender minds might be shaped. The educator's role was largely in the selection of good and proper literature, selecting resources which combined intellectual development with moral edification. The learner's moral edification was directed externally by a teacher, by an editorial committee, or by a school board.

Today the classics of literature, fine essays and poetry still abound. They are rapidly finding their way online. There will be a time in the next ten or fifteen years when every essay or poem that was ever published by McGuffy or any other reputable source will be available in digital format for readers who wish to partake of these edifying materials. But along side such uplifting literature will be objectionable material, countless resources of questionable value, some resources of objectionable content. The supreme difficulty in the Information Age will be the ability to restrict a learner's education to a "sanctioned" body of literature. The discipline required of learners in the postmodern age goes beyond that of all previous generations. The role of education in the age of information will be the development of disciplined readers.

skilled in the art of abductive logic. Since we can no longer filter and select proper materials for our students, our highest calling as educators will be to support students in developing such discipline for themselves.

Whitehead (1929) explained to an earlier generation of teachers that, "discipline is knowledge in the presence of freedom". Giving students the freedom to choose, then supporting them through the anguish of moral and logical choices, this is practice that builds discipline, skill, and moral fortitude. It will be the highest, most valued instructional model for the next few decades.

Summary

In contemplating what the future might hold for education it is sometimes useful to gaze into the past. We have attempted to show how formal knowledge broke free from cloistered protection to broad dissemination in the age of Guttenberg. Knowledge in the the modern period followed logocentric patterns with one-to-many relationships. The postmodern period promises yet greater dissemination marked by a many-to-many relationships. The developments brought about by technology allow for new possibilities. We are seeing trends in education toward distributed, collaborative models of learning. Agency is shifting from center to periphery, from teacher to learner, from author to reader, from librarian to researcher, from curriculum to context. The affordances of public expression have exploded, allowing any school child to represent herself before a world-wide community of learners (5). The affordances of information retrieval have advanced to the point where a simple query can yield a flood of information.

This is where the modern and postmodern minds collide. To the modern mind, there is too much information. The world is exploding with ideas and perspectives that cannot possibly be consumed. We must control what people read so that truth might prevail over misinformation, so that quality might prevail over mediocrity, so that correct ideas might prevail over anarchy. But to the postmodern mind, attempts to control information are futile and naive. What control exists in the postmodern world will emerge -- not from the center, but from the periphery. The genie is out of the bottle. There is no chance of forcing him back. Modern educators have learned how to utilize constraints of the environment as a means of scaffolding in the instructional process. Constraints can limit a field of information, making it more manageable for learners. Constraints of grammar and syntax are necessary for language acquisition. General social behavior is learned from constraints involving etiquette and protocol. We have shown that the Internet overcomes many of the constraints imposed by traditional educational infrastructures. But the freedoms that suddenly emerge are frightening. The modern educator might be tempted to impose artificial constraints on the medium in order to control and manage the educational environment. Software is available at this moment which allows a teacher or parent to filter information and restrict access to objectionable sources on the net. We acknowledge that such artificially imposed constraints may be necessary in the short run to mitigate controversial dilemmas and situations that challenge traditional thinking. But we are persuaded that the real challenge for education is to discover the natural constraints associated with a highly connected and deeply fragmented world. A set of rules or policy guidebook for the postmodern will not be found. But out of distributed knowledge, we are seeing the emergence of a new ethic with an entailing structure of distributed control. The challenge for the postmodern educator is to discover the capabilities and natural constraints associated with distributed pedagogy for scaffolding learners in the age of information.

This paper is available in hypertext:

http://www.cudenver.edu/~mryder/aect_96.html

Notes

(1) Given the fact that Socrates' words placed him in disfavor with the authorities of the time, his reluctance to commit those words to writing is understandable.

(2) Oddly, that mode of information transfer prevails in universities to this day.

(3) Booklearning was obviously not the only form of education. The most common mode of education in the middle ages was neither literate nor oral, it was situated in everyday practice (Lave and Wenger, 1991).

(4) There is, perhaps, another constraining factor associated with a newly gained freedom: fear. In his study of education among third world peoples, Paulo Freire (1993) observed a natural reluctance among prior victims of social oppression to embrace newly gained freedoms. Freiere describes a confusing behavior among many enfranchised citizens as they enter the historical process as responsible participants in society. That fear is often camouflaged in the form of incredulous defense of the old order.

(5) A Department of Education survey shows the number of schools linked to the Internet in early 1996 is approaching 50% and the number of schools involved in accessing the Internet is up 35% from the previous year. (Miami Herald 19 Feb 96 p25)

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Title:

Learner Navigation Patterns and Incentive on Achievement and Attitudes in Hypermedia-based CAI

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Abstract

The purpose of this study was to investigate the achievement and attitudinal effects of learner patterns of navigational behaviors and option choices in using a hypermedia-based computer-assisted instruction (CAI) unit designed for college students. Also investigated were the effects of two incentive structures on achievement and attitudes, as well as the relationships among prior interest, experience, achievement and attitudes. Students were randomly assigned to either a task-incentive or performance-incentive version of a free-access, Hypercard format instructional computer program. Multiple regression analysis revealed that total time spent on instruction and practice and the number of times previous and back selections were made were significant predictors of achievement. Type of incentive did not yield a significant difference in posttest scores or attitudes between treatments. Overall, subjects had positive attitudes toward the instructional program. A positive relationship was found between prior experience with CAI and achievement. The results of this study suggest that college students may be able to accurately judge in what fashion they need to review previously viewed screens in computer programs in order to receive higher posttest scores.

Introduction

Learner control in computer-assisted instruction refers to the control of options within programs (Hicken, Sullivan, & Klein, 1992). Despite the attractiveness and cognitive appeal of learner-centered instruction, results of research on learner control to date have been inconclusive. For example, when given control over content review (Kinzie, Sullivan, & Berdel, 1988), pacing (Gray, 1987), sequencing (Steinberg, 1989), and presentation medium (Ross, Morrison, & Odell, 1989) students gained higher achievement scores. However many studies have indicated no significant differences between learner control or program control (Klein & Keller, 1989) or poorer learning when students control their own learning (Fry, 1972). As a result, Hannafin (1984) and others have called for caution in giving students control over CAI programs.

Based on the work of Carrier and her colleagues (cf. Carrier, Davidson, & Williams, 1985; Carrier, Davidson, WIlliams & Kalweit, 1986) virtually all of the more recent learner-control research has been conducted by providing students with programs in which they either add or by pass instructional elements. Researchers have begun to use programs, called Full-Minus or Lean-Plus, in which students can add or bypass examples, practice items and review (Hicken, Sullivan, & Klein, 1990; Igoe, 1993; Hannafin, 1993). Results of these studies have been inconclusive with regard to the effect of learner control on achievement.

More consistently favorable results have been obtained in studies correlating student attitudes and learner control. Pascal (1971) found that students who could choose the format in which instruction was presented enjoyed the subject matter more. Fisher, Blackwell, Garcia and Greene (1975) reported that students who could choose the difficulty and amount of math practice became more engaged in the instruction than those who could not. Morrison, Ross, and Baldwin (1992) found that learners allowed to choose the amount and context of practice problems had more positive attitudes than learners in a program-controlled treatment.

A factor that has not been widely studied in learner-control studies is incentive to perform. Tennyson and Buttrey (1980) observed that the use of an actual classroom-related incentive, that is, a grade, was missing from most learner-control studies. Whereas a grade would have provided a performance-contingent incentive, many studies have utilized only a task-contingent incentive, in which simple completion of the task constituted student performance. In comparing task-contingent incentives and performance-contingent incentives, Hicken et al. (1992) found that the performance-contingent incentive group performed better on the posttest. When comparing types of performance-contingent incentives, Igoe (1993) found that there were no significant differences between students who selected the grade they wanted to achieve and those who were assigned a specific achievement level. Hicken et al. (1992) advised that further research on incentives in learner-control studies should be conducted.

Many of the instructional programs created for learner-control studies have used hypermedia technologies such as Hypercard and Toolbook. In general, these programs have been primarily linear in format (Freitag & Sullivan, 1995; Schnackenberg, Sullivan, Leader, & Jones, 1995). They have not allowed learners to go back at any time to previous instruction or to branch to other material within the program. Little research has been conducted in which the learners have been allowed to utilize the network-structure of hypermedia. This network-structure frees learners to explore instructional programs using any options and navigational patterns they desire.

Several studies investigating the use of navigational aids in non-linear programs have recently utilized this network structure. When comparing a navigation system that involved jumping to and from an index separate from text displays to one that presented navigation options directly on the text pages, Wright and Likorish (1990) found that adult subjects preferred index navigation in a book-like hypertext program and page navigation for information that was in the form of a matrix. Stanton and Stammers (1990) reported that adults who were trained using a non-linear program were able to carry out a simulated task significantly better than those who were trained using a linear program. Additionally when comparing the effectiveness of using analytical approaches or browsing techniques to find information in a hypertext environment, Marchionini and Shneiderman (1988) found no significant differences among high-school age students.

The purpose of the present study was to investigate the achievement and attitudinal effects of learner patterns of navigational behaviors and option selections while they used a hypermedia-based instruction unit designed for college students. Also investigated were the effects of varying incentive structures on achievement and attitudes, as well the relationships among prior interest, experience, learner achievement and attitudes. Finally, qualitative data regarding students' perceptions of how they used the program and other attitudinal data were collected.

Method

Subjects

Participants in the study were 110 undergraduate students, mostly education majors, enrolled in an introductory computer course at a large southwestern university. The study took place late in the semester, therefore students had already used IBM-PC computers to learn about DOS, word processing, databases, and spreadsheets. Students were told that this section of the course would introduce them to using Macintosh computers and to the concept of "CAI", that is computer-assisted instruction for education. The instructional program constituted a regular assignment for the course, for which they would earn points toward their grade.

Materials

The instructional program was modified from one created by Robert Lievens. It was designed to teach various facts about the prehistoric Anasazi people of the American southwest in a computer-assisted, Macintosh-based Hypercard format. A computer-based data collection program (Dwyer & Leader, 1994) was used to record en-route performance, option-selection and navigational patterns, time-on-task data, time-in-program data, attitude data and posttest data.

For the study, the content was divided into the five units, which taught nine objectives, as follows:

A. Who Were the Anasazi?
    1. Identify the Anasazi, prehistoric Native Americans of the Southwest, from given descriptions.

B. Where Did They Live?
    2. Locate where the Anasazi lived on a map.

C. What Happened to the Anasazi?
    3. Identify the names of the two major phases of Anasazi development.
    4. Given a description of key events in Anasazi history, identify the name of the period of development.
    5. Identify what most agree happened to the Anasazi.

D. How Did the Anasazi Live?
    6. Identify the type of villages the Anasazi lived in at the height of their culture.
    7. Identify features common to their homes, villages and lives.
    8. Identify kivas in pictures of villages, and identify their use.

E. What Did They Use to Make a Living?
    9. Identify the uses of types of tools the Anasazi used around their homes, and for hunting.

Each unit included instructional information and selected-response practice items. Information was presented in the form of text, a reference map, a timeline, and graphic icons that could be clicked on to obtain facts about the icons. Sounds could also be accessed in conjunction with clicking on some of the graphics.

Students navigated through the program by using a mouse tool and selecting buttons, typically presented at the bottom of each screen. On the first screen of each unit, students could choose to review the objectives for that unit. Students could at any time choose to go the "Main Menu". The "Main Menu" button gave students free access to move anywhere in the program at any time. Students could move to different topics, the practice sets, objective screens, or the posttest by selecting these options. They could also skip portions of instruction or practice items by going back to the menu or directly to the practice sets or quizzes.

Each screen also contained arrow buttons in which the students could return to the card they just viewed, the previous card in the stack, or continue to another card in the program. Students could quit the program at any point and later to resume instruction where they finished by clicking the "Quit" button.

In addition to the instructional content, the CAI program included introductory instructions for using the program and pre- and post-instructional attitude questionnaires. The four item pre-instructional questionnaire was designed to measure students' prior interest and prior experience with computers and CAI as well as preference for learning by lecture, video or pictures, or computers. The twenty-one item post-instructional questionnaire measured students' attitudes toward the program content, ease of use, format, and clarity, as well as perceived effort and motivation toward the topic. Additional data were collected on student attitudes and use-patterns through a "notebook" feature built into the software. Every fifteen minutes, the program paused and requested students to write comments about how they were using the program. Patterns of navigational behaviors, option selection and time were tracked by a built-in computer program which recorded every keypress from the students and which was developed to track patterns thought to enhance learning, in particular branching back and forth among instruction and practice activities.

Two versions of the program, differing only in their "incentive" directions in the introduction, were used for the study. Instructional presentation, practice, feedback, and the questionnaires and posttest were identical in both versions. Each version was worth a total of 25 possible course points. Students in the "task-incentive" treatment were informed that they received all 25 course points for simply completing the program, regardless of their posttest score. Students in the "performance-incentive" treatment were told that they would earn points based on their scores on the program posttest; they would earn 25 points if they scored at least 70% on the posttest.

Procedures

Prior to receiving a program disk, students were given a ninety-minute presentation about CAI and a demonstration about how to use a Macintosh computer. Hands-on experience was not included in the presentation, however the demonstration included large-screen projected computer screen images and verbal explanations. The instructional program itself was integrated into the course as a regular assignment designed to introduce the students to computer-assisted instruction.

After the presentation, each student was given a disk at random representing one of the two versions of the program. Separate instruction sheets which gave directions for using any of the campus computers were included with the disks. Students were instructed that they would have two weeks to complete this assignment, and would be given one lab day during one of the class sessions in which to complete it. Several experimenters and the course instructor were available at various computer sites to answer any questions about the program. Program disks were collected two weeks later in the next regular class session.

Criterion Measures

The program included a 20-item multiple-choice posttest which measured achievement on the objectives of the instructional program.

The four-item pre-instructional questionnaire measured students' prior interest, prior computer and CAI experience, and attitudes toward computers. The twenty-one item post-instructional attitude questionnaire assessed students' satisfaction with the material, perceived effort, desire for more information, and continuing motivation. (The items included in these two instruments are included in Tables 2 and 3.)

Design and Data Analysis

Analysis of variance was used to analyze achievement and attitudinal effects of the two incentive structures. Backward multiple regression analysis was performed on the patterns of navigational behaviors and time as related to achievement. Chi-square analysis was used to determine the relationships among prior interest, experience, learning achievement and attitudes. Students' perceptions of how they were using the program were categorized and frequencies tabulated.

Results

Achievement

Students' posttest scores were relatively high, as shown in Table 1. The mean overall score was 17.26 out of 20, with the range of scores being from 11 to 20. Students in the performance incentive treatment (M = 17.36) did slightly better than those in the task incentive treatment (M = 17.16), but this difference was not significant.

Table 1
Posttest Scores by Incentive Treatment

Treatment	Mean	SD	N
Performance incentive	17.36	1.81	55
Task incentive	17.16	2.07	55
Total	17.26	1.94	110

Note: Posttest scores ranged from 11 to 20 of 20 possible.

Attitudes

Pre-instructional Attitudes. Students' responses to the items on the pre-instructional questionnaire are shown in Table 2. As can be seen, students were relatively neutral (2.38 on a scale from 1 to 5) in their prior interest in the topic of early Native Americans in the Southwest. The two "experience" items used a scale of from 1 (a lot) to 3 (none/not at all). Students indicated they had little prior experience with the MacIntosh computer (M = 2.15), and even less experience with CAI (M = 2.31). Students' mean score of 1.98 on the learning mode preference item indicated some preference for learning by computers over lecture or video.

Table 2
Pre-instructional Attitude Data

Question	Mean	SD
1. Interest in topic	2.38	.98
2. Mac experience	2.15	.66
3. Prior CAI experience	2.31	.66
4. Learning mode preference	1.98	.73

Note: N = 110. Q1 scores ranged from 1 (high) to 5 (low). Q2 and Q3 scores ranged from 1 (a lot) to 3 (none/not at all). Q4 scores were 1(lecture), 2(computers), and 3 (video/media).

Post-instructional Attitudes. Mean scores on the 21 items on the post-instructional attitude questionnaire are shown in Table 3. Scores ranged from 1 (Strongly Agree) to 5 (Strongly disagree). As can be seen, students' attitudes were generally positive, with all mean scores being more positive than 3, or neutral. Students indicated somewhat stronger positive responses on items related to how easy the program was to use, such as "I knew where to click" (M = 1.55) and "It was easy to more around in the program" (M = 1.76). Students also indicated they felt the program was well-designed, for instance, "The objectives in this clearly describe the content and practice" (M = 1.74), "The practice helped me to learn the content" (M = 1.65), and "The content in Anasazi was easy to understand" (M = 1.58). Students indicated that they liked using the computer to learn this content, for example, "The computer program was a good way to learn about the Anasazi" (M = 1.64), "I like learning with the computer" (M = 1.77), "If I had the opportunity, I would choose to learn about another topic using a computer program like this one" (M = 1.97), and "I would want to use another program like this one to learn about another subject" (M = 1.79). Not surprisingly, in that this was a computer course mainly for education majors, students were somewhat less positive, or more neutral, in their attitudes about the Anasazi content, for instance, "The content was interesting" (M = 2.04), "I am interested in learning more about the early Native Americans of the Southwest" (M = 2.54), and "If I had the opportunity, I would choose to learn more about the Anasazi" (M = 2.57). Finally students' mean attitude scores indicated different amounts of enjoyment and satisfaction with the five different units. The unit students enjoyed the most was "How Did the Anasazi Live" (M = 1.92) which included information about houses and villages and many sounds, followed by "What Did They Use to Make a Living?" which included many icons of tools which accessed information about each (M = 2.05). Next students enjoyed "What Happened to the Anasazi?" (M = 2.17), based on the timeline, and finally "Who Were the Anasazi" and "Where Did They Live?" (M = 2.05). Students indicated an almost equally positive perception about how effectively each of the units was presented with mean scores ranging from 1.81 to 1.86.

Students' post-instructional attitude mean scores overall were subjected to ANOVA to determine any incentive treatment effects on overall attitudes. Results on these overall mean scores were 40.60 for performance incentive and 40.42 for task incentive; these differences were not significant.

Results of correlational analyses with attitude data. Chi-square correlational analysis among the pre-instructional attitude scores and posttest scores indicated only one significant positive relationship ($p<.05$), which was for prior experience with CAI. A similar relationship appeared in the results of the chi-square analysis among the post-instructional attitude scores and posttest scores. A significant positive relationship was also found between desire to learn other content using CAI and posttest scores.

Table 3

Post-instructional Attitude Data

Question	Mean	SD
1. The objectives in this program clearly described the content & practice.	1.74	.60
2. I used the objectives to guide me in the program.	2.15	.86
3. The content in Anasazi was easy to understand.	1.58	.61
4. The content was interesting.	2.04	.78
5. The practice helped me to learn the content.	1.65	.74
6. It was easy to move around in the program.	1.76	.83
7. I knew where to click.	1.55	.72
8. The computer program was a good way to learn about the Anasazi.	1.64	.73
9. I would want to use another program like this one to learn about another subject.	1.79	.94
10. I like learning with a computer.	1.77	.76

11. I am interested in learning more about the early native Americans of the Southwest.	2.54	.92
12. If I had the opportunity, I would choose to learn more about the Anasazi.	2.57	.98
13. If I had the opportunity, I would choose to learn about another topic using a computer program like this one.	1.97	.88
14. I enjoyed learning the material in the "Who Were the Anasazi" and in the "Where Did They Live" sections.	2.05	.66
15. The material in the "Who Were the Anasazi" and in the "Where Did They Live" sections was presented effectively.	1.84	.53
16. I enjoyed learning the material in the "What Happened to the Anasazi" section.	2.17	.82
17. The material in the "What Happened to the Anasazi" section was presented effectively.	1.88	.69
18. I enjoyed learning the material in the "How Did the Anasazi Live?" section.	1.92	.74
19. The material in the "How Did the Anasazi Live?" section was presented effectively.	1.81	.66
20. I enjoyed learning the material in the "What Did They Use to Make a Living?" section.	2.05	.75
21. The material in the "What Did They Use to Make a Living?" section was presented effectively.	1.86	.66

Note: N = 110. Scores ranged from 1 (Strongly Agree) to 5 (Strongly Disagree).

Navigation and Choice Patterns

Mean scores on time and learner navigation and choice patterns are shown in Table 4. Students chose to return to instruction from practice exercises an average of 2.8 times, and chose previous and back options an average of 12.8 times. The average total amount of time spent by students on instruction and practice was about 28 minutes (1679 seconds). The mean number of instruction and practice cards viewed was 193 per student. As the total program included 133 cards, including instruction, direction, questionnaire and test screens, this number indicates that many students viewed instruction and practice cards more than once.

Table 4

Mean Scores on Learner Time and Navigation Variables

Variable	Mean	SD
Number of Times Chose to Return to Instruction from Practice **INSTRTRN**	2.8	2.7
Number of Times Chose Previous and Back **PRRTCNT**	12.8	19.6
Time (in seconds) Spent on Instruction and Practice **TOTTIME**	1679	813
Total Number of Instruction and Practice Cards Viewed **TOTCOUNT**	193	112

Multiple regression analysis performed to investigate the predictive value of several student time and navigation patterns on posttest scores is shown in Table 5. This analysis revealed that both total time spent on instruction and practice cards (Tottime) and number of times previous or back selections were made (Prrtcnt) were significant predictors of achievement ($p<.05$).

Table 5

Backward Regression Analysis on Choice and Navigation for Posttest Results

Variable Remaining	R Square	F	p
prrtcnt & tottime	.06190	3.530	.0328
prrtcnt	.04489	5.07609	.0263

* Significant @ the .05 level

Students' Perceptions of How They Used the Program

Data gathered from the "notebook" feature is shown in Table 6. Ninety-eight of the 110 students used the notebook feature. The most frequently-cited response described what they were doing in the program (86), such as answering questions or taking quizzes. Almost as many students (85) indicated what they liked about the program, while 33 described features they did not like about it. Many students (84) stated that they were learning about Anasazi Indians, while 33 students said that the program was difficult. Thirty students volunteered that they liked having the option to go back and review screens and information and 28 students stated that they were using different mouse tools. Twelve students wrote that they had no comment.

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Table 6
Students' Perceptions of How They Were Using the Anasazi Computer Program

Responses	Number of Responses
Answering practice questions, taking practice quizzes, taking final quiz, reading text, doing surveys, taking notes.	86
Liked program, program is interesting, easy to use, information is clear, likes immediate feedback, likes pictures and sound.	85
Learning about Anasazi Indians, going through program.	84
Program is hard and confusing, got lost in program, program is long and boring, don't like program.	33
Would rather learn from person or book, problems using mouse, survey too long, notebook feature is bothersome.	33
Likes being able to go back and review information in program, using review options.	30
Using mouse, buttons, arrows, etc..	28
No comment.	12

Note: N = 98 out of 110 subjects used the notebook feature. Subjects could mention a number of responses. Categories were collapsed.

Discussion

This study is one of the first to investigate learners' patterns of choices and navigation pathways in a completely free-access network-structure hypermedia program. There were no effects in this study for incentive treatment on either performance or attitudes. This is likely to have been a result of the compressed high scores on the posttest. Most students did very well, with a mean of 17 out of 20. This brings to mind Clark's (1983) contention that well-designed instructional methods are the key to success. Both treatments included carefully-designed instruction, which matched the instructional objectives and test items to the lesson content. Students' responses to attitude items also indicated their satisfaction with the instructional design of the CAI program.

The results of this study also indicate that college students generally like CAI programs, even those which teach content they may initially have been neutral about. Contrary to expectations, it appears that their prior interest may not be related to their performance. Similarly, their attitudes toward the CAI program were generally favorable. These attitudes, however, were also not related to their performance.

Results of this study did indicate that there may be a relationship between performance and prior experience, not with computers, but specifically with routine integration of CAI into college courses to teach content. The results of this study indicate that the more experience students have with CAI the better this method may enhance their learning of content.

A similar relationship between performance scores and students' desire to learn other content using CAI may indicate that more able students like learning using computers better. This result, too, seems to support the idea of providing college students with more experience using computers to learn, if that is to be the method of delivery in a course.

Other results indicate that the total time spent on instruction and practice cards and the number of previous or back selections made were significant predictors of achievement. That time spent on instruction affected achievement was not surprising. The effects of students' decisions to go back to previous instruction, however may be an important finding for developers of CAI. Supporting data, in the form of students' perceptions of how they used the program, also indicate that students liked having the option to go back to previous screens wherever and whenever they desired.

Results of several previous learner-control studies indicate that learners do not know how to manage their own learning to improve achievement (Pollack and Sullivan, 1990; Ross and Rakow, 1981; Hannafin & Sullivan, 1994). However, in these studies students were either required to make choices before the instruction began or as they were learning new material. Students were not given the option to manage their own review of previously viewed screens of information. The findings from the present study indicate that even though learners may not be able to make instructional choices that improve achievement prior to learning new material, collegiate learners may be able to judge in what fashion they need to review previously-viewed instruction and practice in order to achieve higher posttest scores.

The results of one study cannot be taken as a prescription for designers or researchers. It is suggested that future studies be conducted investigating the effects of going back and other patterns of learners' navigational behaviors in free-access CAI programs more deeply. Studies should also be conducted with other types of learners in other settings, to determine the learning and attitudinal effects of incentive treatments, and navigational patterns and choices, as well as the relationships among prior interest, prior experience, attitudes and performance.

Table 7
Post-instructional Attitude Data by Treatment

Treatment	Mean	SD	N
Performance incentive	40.60	10.01	55
Task incentive	40.42	8.91	55
Total	40.51	9.43	110

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Title:

So Many Colors, So Many Choices The Use of Color in Instructional Multimedia Products

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The average person can distinguish between 10,000 and 20,000 colors (Pettersson, 1993; Tufte, 1990). State-of-the-art computers being used today for instructional multimedia products have monitors capable of displaying different colors beyond these figures and well into the millions. Designers are given virtually unlimited control over the factors that govern the display of those colors. Not only can designers decide when and where to use color, but they can also determine the physical characteristics of the colors themselves. According to Keller and Burkman (1993), people have come to expect media products to have high-quality color, and indeed, most prefer instructional products that have color over those that do not. With the ready availability of color on today's computers, what is a designer supposed to do? There are so many colors, so many choices.

This paper first briefly examines how color is displayed on modern computer monitors and how humans perceive color. The three following sections consider three primary uses for color: affective, structural, and cognitive. The succeeding section discusses problems inherent to the use of color and offers some solutions. Finally, the paper concludes with recommendations for the proper and effective use of color in instructional multimedia products.

What Is Color, and How Does It Get on a Computer Monitor?

Color is a sensation and not a physical entity, according to Humphreys (1993). Murch (1983) maintained that the way we perceive color is the result of many factors: the capacity of the object in question to reflect and absorb certain wavelengths of light; the properties of the light source illuminating the object; the medium through which the light travels; the properties of the surrounding objects; the biochemical state of the eyes of the observer; and the observer's previous experience with the object or its colors. Although all of these factors are of concern to the designer, he or she usually has control over the first factor alone. That is, the designer can only specify what colors the monitor should display. Because of the intervening factors between the display and the eyes of the observer, the designer cannot control what colors the observer actually perceives.

As Norman (1990) pointed out, although color organization can be traced back to the ancient Greeks, it was Sir Isaac Newton who first brought us the now-familiar color wheel, the principles of which have become an underlying assumption for virtually every color model since. An example of one of these principles is that mixing together red, green, and blue paint produces a mixture approaching black. Producing new colors in this manner is referred to as an additive process and is the one with which most people are familiar. Unfortunately, color on a computer monitor is not accomplished by mixing colored pigment, but rather by mixing colored light. In this system, called subtractive, combining red, green, and blue light produces white. According to Norman, prior to the advent of color computers, very few people (theatre lighting designers being one exception) had the opportunity to combine colors using a subtractive process.

More specifically, a monitor's cathode ray tube produces an image when electrons strike the phosphorescent material lining the front interior of the glass. As Thorell and Smith (1990) described, the phosphors are arranged in triads of three primary colors: red, blue, and green. These phosphors are individually energized by three different electron beams and hence selectively lighted. Illumination of all three phosphors in a triad produces white, and illuminating none produces black. Stimulating different combinations in the triad produces secondary colors (for example, lighting the red and green phosphors results in yellow). By varying the intensity of the electron beams, a full spectrum of colors can thus be produced.

While color on a computer is constructed using red, green, and blue phosphors, humans commonly refer to color by three different interrelated components: hue, saturation, and lightness. Murch (1985) defined hue as the basic component of color (which depends on the specific wavelengths of light received), saturation as the purity of hue (which depends on the range of wavelengths received), and lightness as the amount of light reflected (which depends on the presence and amount of achromatic color—black, gray, and white). For example, "red" is a word used to describe hue; "pink" is a word used to describe saturation; and "dark" is a word used to describe lightness. So when someone describes an object as being "dark pink," for example, he or she has simultaneously used hue, saturation, and lightness in the description.

Samit (1983) contended that it is important for the designer to understand how a computer display's system works since colors on a computer are produced in the unfamiliar additive red-green-blue (RGB) system, but are perceived in the familiar hue-lightness-saturation (HLS) system. Murch (1983) described how the gap between these two color systems is bridged by most computer systems having an interface which allows the designer to manipulate controls for hue, lightness, and saturation directly and interactively.

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The Affective Role of Color

Many authors have argued that color adds a strong affective dimension to visual displays. Pettersson (1993) suggested that color enhances the perception of a visual message; Shneiderman (1987) concluded that color can add accents to an uninteresting display; Tufte (1990) maintained that color enlivens and informs the computer user; Dwyer and Lamberski (1983) noted that color makes displays attractive and emotionally appealing; and Dondis (1973) claimed that color is "the aesthetic frosting on the cake" (p. 50). More substantively, Samit (1983) reported that tests have indicated that viewers actually appear to feel they have a better understanding when images are displayed in color.

As Davidoff (1991) observed, there are particularly strongly held beliefs about emotional responses to color. For example, the color red is said to be make one feel warmer, to arouse one to action, to accelerate the passage of time, and to increase one's strength. On the other hand, Sharpe (1974) noted that blue (at the opposite end of the spectrum from red), is said to make one feel cooler, calmer, and more in control. Davidoff reported that there are very few well-documented and controlled studies that actually verify the effects of color on behavior. What is important for our purposes is that people *believe* that color affects them both emotionally and physically.

Structural Uses of Color

When designing screens for the computer-user interface, the designer must consider how the structure and the various functions of the interface will be communicated to the user (Brown, 1989; Faiola & DeBloois, 1988; Laurel, 1990; Pettersson, 1989; Shneiderman, 1987). Appropriate use of color can be used as an element in this communication process.

One such way in which color can be used structurally is in screen menu design. As an example, Shneiderman (1987) suggested showing all menu items in one color, the title in another color, the instructions in a third color, and error messages in yet a fourth color. When screen space is at a premium, he also recommended using dissimilar colors to distinguish close but logically distinct fields. Rambally and Rambally (1987) also suggested using different colors to separate prompts, commands, input/output (I/O) fields, and the like.

Using color for text is another option available to the designer. Both foreground and background colors need to be taken into account. Isaacs (1987) and Brown (1989) both advised that the two colors should be chosen so that the greatest contrast in lightness is obtained. Keyes (1993) noted that since black and white have the maximum contrast in lightness, this combination has maximum visibility. Keyes added that instead of black, dark shades of green, blue, and violet could be used with only a small decrease in legibility. Assuming that the lightness/contrast rule is followed, Clausing and Schmitt (1989, 1990) demonstrated that the colors chosen have no significant effect on either reading rate or comprehension. Nevertheless, numerous authors have offered specific suggestions for which colors to use. Humphreys (1993) maintained that dark letters on a light background were more legible than the reverse, Pettersson (1989) proffered black or dark brown text on a light yellow background as being the most legible, Gillingham (1988) cited a Swedish study that claimed blue or green on white led to increased accuracy and higher subjective ratings, and Isaacs concluded that green text on a black background is the best choice.

Colored text can also be used to provide signals to the user. Marchionini (1988) suggested that color could be used in hypertext to indicate links. Cook and Kazlauskas (1993) recommended using two different colors in feedback after an incorrect response: one color to indicate what the user should do next and a different color to elaborate on why the user was incorrect. Keyes (1993) advocated using color for information types that are difficult to signal typographically, such as warnings, hints, user-entered information, cross-references, and section dividers.

Shneiderman (1987) suggested that when exceptional conditions or time-dependent information must be relayed, color can be used to attract the user's attention. Occasionally, there are times when the computer requires the user to attend to something unrelated to the user's current task. If the computer's need is not urgent, rather than having it forcibly and abruptly interrupt the user with a dialog box, Baecker and Small (1990) proposed having a less intrusive alerting icon that changes color to become progressively more red as it is ignored for an increasingly longer period of time. If time is more of the essence, Faiola and DeBloois (1988) advocated using highly saturated colors to attain a quick response.

When designing the structure of an interface with color, designers should also be aware that color can provide some overall physiological benefits. According to Tufte (1990), softening a bright white background with color calms video glare. Smith (1987) reported that the use of multicolor screens have reduced reports of visual stress or fatigue from users who had previously viewed information on black-and-white or single-color screens. Smith also contended that information on a multicolor screen can be perceived at a greater distance than a black-and-white version of the same information.

Cognitive Uses of Color

Color may also be useful for enhancing learning. Faiola and DeBloois (1988) claimed that color "can aid memory and enhance the understanding of information" (p. 16), Dwyer and Lamberski (1983) postulated that color can make instructional products "more effective in facilitating student achievement of specific kinds of learning objectives" (p. 304), Milheim and Lavix (1992) declared that "color can be used effectively . . . to aid in student learning" (p. 18), and Keyes (1993) averred that color can create "a visual layer that we separate perceptually" from other information (p. 646). Beyond the generalities, in what specific ways can color enhance learning? Numerous researchers and authors have suggested using color to highlight salient features, color code related bits of information, decrease the cognitive load, and simplify complex information.

Highlighting salient features. As Tufte (1990) noted, foremost among color's attributes is its ability to make things stand out, to draw the user's attention. Borrowing from classical cartography, Tufte noted that small spots of intense, saturated color can be used effectively to convey information by making it stand out from the rest of the illustration. Winn (1993) added that the highlighting color doesn't even have to correspond to the colors of things in the real world: using bright red to color the forearm of an athlete throwing a javelin, for example, is not meant to imply that the arm is in fact red, but rather to draw attention to the position of the arm. In a meta-analysis of the research on the use of color in visual displays, Christ (1975) concluded that using color to help users find and identify features is as much as 200% more effective than using size, brightness, or shape.

Color coding. Perhaps no instructional use of color has been as thoroughly considered and studied as color coding. Color coding is used constantly in everyday life, allowing us to readily associate particular messages with certain colors (Brown, 1989; Durrett & Trezona, 1982; Faiola & DeBloois, 1988; Rambally & Rambally, 1987). According to Durrett and Stimmel (1987), color affects the coding of information in human memory. They cited numerous studies in which color was used as an organizational and differentiating factor to help subjects recall and retrieve information. Somewhat surprisingly, Dwyer and Lamberski (1983) concluded that even if the colors chosen do not contribute to the message content, color can nevertheless still facilitate the retrieval of essential learning cues.

Christ (1984) offered one of the simplest ways to use color coding: identifying categorical information. The number of categories may be as few as two, such as in air traffic controller displays where one color is used to designate planes over a certain altitude and another color for planes below. Christ noted that although with training users can learn to increase the number of identifiable colors in a display, he recommended using fewer than ten. Others have advocated as few as three (Milheim & Lavix, 1992) to as many as eleven (Rambally & Rambally, 1987). Other applications of using color to categorize information include parsing the different parts of mathematical statements (Thorell & Smith, 1990), showing the nesting levels of a block-structured programming language (Shneiderman, 1987), and delineating the contours in an architectural drawing (Norman, 1990).

Color can also be used to order logically related data. In an example from chemistry, Thorell and Smith (1990) suggested using different saturations of the same color to code different concentration levels—high saturation to represent maximum concentration and desaturation for minimum levels. Similarly, in organizational charts, executive officers could be shown in saturated colors and divisions that report to them in desaturated values of the same colors. In an accounting environment, bright red could be used to indicate a payment extremely overdue and lighter shades to represent payments overdue by fewer days.

Color can also be used to code processes. Among their numerous examples, Thorell and Smith (1990) demonstrated using color coding to indicate the decomposition of a heated chemical compound, to represent the body's reactions to different amino acids, to signify the changes in stress loadings on solid objects, and to assist doctors in interpreting CAT scans.

Decreasing the cognitive load. Keyes (1993) postulated that we can use color to extend the cognitive limit by creating a visual layer separate from monochromatic typographic and spatial cues. Because color is perceived preattentively (automatically), less effort is required and the user can handle more information. In what is known as the neurophysiology of modularity, Davidoff (1991) asserted that in the visual system, color provides a secondary, pathway to the brain, parallel to that for other visual information. Adding credence to the hypothesis of modularity, Durrett and Stimmel (1987) related an experiment in which color was shown to be an extremely effective adjunct in learning nonsense syllables.

Cognitive load is closely allied to color coding. For example, since red is traditionally associated with stop, yellow with caution, and green with go (Brown, 1989; Durrett & Trezona, 1982; Faiola & DeBloois, 1988; Shneiderman, 1987), users do not have to learn new associations between these colors and their meanings. Thorell and Smith (1990) added that to most people, light colors give the impression of large sizes, light weights, tall heights, and close distances; dark colors give the opposite appearances. Accordingly, designers should be able to incorporate these associations with colors into their designs and expect users to respond accordingly.

Simplifying complex information. Color's propensity to make things stand out combined with its ability to code related items makes it an effective way to simplify complex information. Keyes (1993) argued that color simplifies by visually organizing and classifying information, clarifying both differences and relationships. As a simple example, Thorell and Smith (1990) described using colors to show the magnitude of change in an event: small changes in color (blue to green, for example) to signify small changes in magnitude and large changes in color (blue to orange) for large changes.

In addition to perspective, artists have long used color in three-dimensional drawings to separate the near from the far. Norman (1990) noted that grayer, desaturated colors appear farther away than more intense colors, giving the illusion of depth. Helping a user visualize three dimensions on the flatland of the screen can have profound learning effects. For example, Mayes, Kibby, and Anderson (1989) observed that significant advances were made in the understanding of molecular chemistry with the advent of computer graphic systems capable of displaying complex three-dimensional molecular structures using color to show grouping.

Problems and Solutions

As with any design element, color has certain potential problems associated with its use. Many authors have alerted us to the "color blindness" of some users (Brown, 1989; Durrett & Stimmel, 1987; Humphreys, 1993; Rambally & Rambally, 1987; Shneiderman, 1987; Thorell & Smith, 1990). As Thorell and Smith explained, our eyes have receptors called cones which fall into three groups according to their sensitivity to the primary colors of red, green, and blue. Deficient color vision occurs when any one or more of these three groups has insufficient sensitivity. True color blindness—being able to see only shades of gray—is exceedingly rare. Silverstein (1987) put the figure at less than 0.003% (3 people in 100,000). Partial color blindness is the total inability to perceive one of the three primary colors. Silverstein estimated that a little over 2% of the population have one or more forms of this deficiency. The most common color deficiency is not really color blindness, but rather color weakness. According to Silverstein, approximately 1% of the population is weak in perception of red and another 5% in perception of green. Consequently, about 8% of the population has some sort of color deficiency. Depending on the type, color deficiencies are 10 to 100 times more prevalent in males than in females. It is important to note that all color deficiencies affect only the perception of different hues—all color-deficient individuals can still perceive differences in lightness and saturation.

There are several ways in which the designer can compensate for color deficiencies. As has already been noted in several examples, instead of using different hues, the designer can use either different saturations or different levels of lightness to represent different entities. When different hues are deemed necessary, however, Keyes (1993) recommended varying the individual saturations so that the contrast is accentuated (for example, instead of using bright red and bright green, consider using bright red and pale green—even the totally color blind will be able to perceive the difference). Another alternative is to use what is called "redundant cueing." Instead of using only color to signify differences, Durrett and Trezona (1982), for example, suggested using shapes or labels in addition to colors.

Because of the physiological structure of our eyes, certain colors create certain problems. One limitation outlined by Humphreys (1993) is that the lens of the eye is not color corrected, thereby causing pure, saturated colors at the same distance to appear to be at different distances. Along these same lines, Samit (1983) explained how the eye cannot precisely focus on all colors together. For instance, since the eye cannot focus on red and blue simultaneously, the muscles will be forced to focus alternately on one color and then by the other, with resulting eyestrain. Samit also noted that because the center of the retina is nearly devoid of blue receptors (even in people with normal color vision), small blue objects virtually disappear when we try to focus on them. Two solutions present themselves immediately: avoid pure, saturated colors at opposite ends of the spectrum (Durrett & Trezona, 1982), and don't use blue for fine lines and text (Humphreys).

Another problem with using color is that not everyone responds to color in the same way. There are cultural, gender, age, and occupational differences. For example, Thorell and Smith (1990) pointed out that in Japan green implies youth and energy, but in France it connotes criminality. In the United States, yellow stands for caution and cowardice, while it signifies happiness and prosperity in Egypt. Several studies have attempted to show that males and females differ in their color preferences and responses (Davidoff, 1991; Krishna, 1972; Sharpe, 1974). Sharpe claimed that older people prefer bright primary colors (perhaps because color acuity declines with age), while Durrett and Stimmel (1987) found that children are not able to utilize color coding as quickly as adults can. While blue represents corporate reliability to financial managers (as in "Big Blue" [IBM]), Thorell and Smith pointed out that blue represents death to health care professionals (as in "code blue"); red means danger to process control engineers, but healthy to health care professionals.

Again, the solution is for the designer to know the audience and to conduct prototyping and user-acceptance tests (Brown, 1989).

Using colors inappropriately or using too many colors can create what Albers called "1 + 1 = 3 or more" (as cited in Tufte, 1990, p. 53). That is, certain uses and combinations of colors can create unintentional artifacts or visual "noise" (Tufte, 1989). We have all seen, for example, the kind of optical illusion where the image seems to literally vibrate because of the intensity of the colors. Tufte's (1989) solution was to use the colors found in nature, since they offer some measure of a accepted visual harmony.

Recommendations

Color is undeniably a part of our lives. We use colors to help identify, categorize, and locate things. We use color terms to express emotions ("feeling blue," "in the pink," "green with envy," and "yellow-bellied"), to ascribe motives ("yellow journalism," "pinko," "red herring," and "true blue"), to denote financial states ("in the red" and "in the black"), to describe qualities ("purple prose," "greener pastures," and "red letter day"), to compare things ("more [of something] than there are colors in the rainbow," "black and white," and "shades of gray"), to express actions ("color my opinion" and "looking at the world through rose-colored glasses"), and to advertise ("Coca-Cola red," "Pepto-Bismol pink," and "Kodak yellow"). It seems only appropriate that designers should take advantage of what color has to offer in both the affective and cognitive domains.

In order to incorporate color aesthetically and effectively into instructional multimedia products, designers have at their disposal a wealth of information from the fields of graphic design, fine arts, psychology, behavioral science, physiology, optics, cognitive science, semiotics, linguistics, cartography, human factors engineering, ergonomics, military science, architecture, and anthropology. Knowing how color is produced and perceived should help the designer better understand the contributions (and detriments) that color can offer. Although good instruction can be accomplished without using any color whatsoever, color may provide an additional factor in human encoding processes.

Because computers now have millions of colors available, there is a tendency for some designers to overdo it. The best advice in this regard came from Tufte (1990): "Above all, do no harm" (p. 81). Too much color can be distracting, and has even been shown to degrade performance on memory and recognition tasks (Christ, 1975, 1984; Dwyer & Lamberski, 1983). Screen designers would do well to follow the lead of graphic artists who design in black, white, and shades of gray before they ever add color. This practice enables them to judge overall balance, harmony, and clarity (and discover any potential problems for the color deficient).

The full range of uses for color has yet to be fully explored. Some of what Salomon (1990) called "new uses for color" (p. 269) hold promise for instructional products. As an example, Salomon explained how a document's icon on the desktop could be colored to indicate its age—yellow for new documents, through progressively duller shades of brown for older documents. Color could also be used to provide additional functional information to the user. Most computer operating systems today use some sort of icon to indicate that the computer is currently busy—the wristwatch on the Macintosh and the hourglass in Windows are two such examples. When the user might be interested in knowing more precisely the internal workings of the computer, Baecker and Small (1990) recommended having an icon that is blue to indicate that the current action is totally CPU-bound, yellow to indicate totally I/O-bound, and colors in between blue and yellow to indicate more balanced processes. Color has also started to play a role in the implementation of so-called guides. The Macintosh's System 7.5, for example, uses color dynamically to highlight the next step in a process. Color could also be used to help young users locate hidden or secret information in a game-like environment. By having the cursor change color as it is moved about the screen, children could be told when they are "getting hot" (red) or when they are "getting cold" (blue).

Much has been written about the instructional use of color. However, authors disagree on advice and their studies often contradict one another. It is clear that additional research is necessary. Durrett and Stimmel (1987) noted the following irony:

> The amount of research done on color as a variable in learning, attention, and coding reached a peak in the late 1960s and early 1970s, declined slightly during the 1970s, and declined dramatically between the late 1970s and the present. This is paradoxical because the use of color in the media of instruction and the potentials for use of color in instruction has grown dramatically. (p. 249)

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Title:

Cooperative Software for the Internet

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Classroom teachers have long used group activities as part of their repertoire of teaching techniques. Having students work together in groups sometimes produces meaningful results and sometimes doesn't. Personalities, goals, the group dynamic, the teacher's level of supervision, and myriad other factors all play a role in the efficacy of the collaboration. One specific kind of group activity which has a history of success is cooperative learning. Although social psychological research on cooperation can be traced back to the 1920s (Slavin, 1977), classroom research did not begin in earnest until the 1970s. At that time, four groups of researchers working independently started to develop and research cooperative learning methods for the classroom (Slavin, 1990). Slavin's team at Johns Hopkins University developed "Student Teams–Achievement Divisions" (STAD) (Slavin, 1978) and "Teams–Games–Tournaments" (TGT) (DeVries and Slavin, 1978); Aronson , Blaney, Stephan, Sikes, and Snapp (1978) designed the "Jigsaw" technique; Sharan and Sharan (1976) produced the "Group Investigation" method at the University of Tel-Aviv; and Johnson and Johnson (1975) working at the University of Minnesota devised the "Learning Together" model for cooperative learning. Although the precise details and the full research results of these pioneering efforts are beyond the scope of this paper, it is instructive for the purposes of this paper to examine the basic premise of each.

Cooperative Learning Techniques

Student Teams–Achievement Divisions

In STAD, each group comprises four members, selected toward achieving a mixture of performance levels, gender, and ethnicity. The teacher presents the lesson in a conventional manner, after which the students work within their groups—now called "teams"—to ensure that all team members have mastered the lesson. Within the team, the students can use a variety of techniques to help each other learn the material. After a suitable period of time, the students then take a quiz individually. A student's quiz score is then compared to his or her own past average, and points are awarded for meeting or exceeding that average. These points are then pooled for the entire team to arrive at a team score. Teams that attain a pre-specified level receive certificates or other rewards (Slavin, 1986).

Teams–Games–Tournaments

Like STAD, TGT has the same teacher presentation of the lesson and the same group composition. Instead of quizzes, however, a TGT-based lesson concludes with a tournament in which students compete with members of other teams to earn points for their own teams. A round of the tournament pits students against other students with similar past achievement records. In this manner, low achievers are competing against other low achievers, for example. As a student's cumulative achievement record changes, he or she is "bumped" to a different level. As during the quizzes in STAD, team members are own their own during the actual tournament. The winner of the round contributes points to his or her team's overall score. Also as with STAD, high-scoring teams earn rewards (Slavin, 1986).

Jigsaw

In the originally Jigsaw technique, students are assigned to six-member teams to work on academic material which has been divided into six different sections. Each team member then studies his or her assigned section. Next, all the students who have studied the same section (one student from each group) meet to form an "expert group" to discuss what they have learned. The students then return to their original teams and take turns teaching each other the various sections (Aronson, et al., 1978).

Group Investigation

Unlike the previous methods, the groups in Group Investigation are not necessarily assigned by the teacher. Like Jigsaw, Group Investigation is a task specialization method. The teacher begins by assigning a broad topic for inquiry. The students then break the topic down into subtopics based on their prior knowledge, backgrounds, and interests. Teams, ranging in size from two to six students, are formed by those sharing a common interest. The students then investigate the topic for their groups and prepare a final report to present to the entire class. Traditionally, evaluation for Group Investigation focuses on higher-level thinking skills, with the teacher constantly monitoring each student's academic activity (Sharan & Sharan, 1976).

Learning Together

As in STAD and TGT, Learning Together is based on four-to-five-member groups assigned by the teacher. The members of each group then work together to achieve a common goal, usually the completion of an assignment sheet handed out by the teacher. Individual students are required to demonstrate that they have individually mastered the material. Additionally, Learning Together emphasizes interpersonal and small-group skills by having the students discuss how well their groups are working together to achieve the goal. The developers of Learning Together recommended team grades rather than rewards or certificates (Johnson & Johnson, 1975).

Student Team Learning

Since the 1970s, these same researchers and others have continued to refine the older cooperative learning techniques and develop new ones. According to Slavin (1990), more than half of all studies of practical cooperative learning techniques, including those cited above, involve what Slavin called "Student Team Learning" methods. The overarching philosophy behind Student Team Learning is that "the students' tasks are not to *do* something as a team but to *learn* something as a team" (Slavin, 1990). This result can be achieved only if all of the team members learn the objectives being taught. Regardless of the name or the specific details, there are three concepts central to all Student Team Learning methods: team rewards, individual accountability, and equal opportunities for success.

Team rewards may consist of certificates, other forms of recognition, or grades. Teams do not compete for limited rewards. If a team reaches a certain criterion, it receives the reward. Teams with equivalent results receive the same reward. Individual accountability ensures that the team's success depends on each of the individual team members. Knowing this, the team focuses its activity on helping and tutoring one another to learn the material. Equal opportunities for success is accomplished through the manner in which rewards are given for a student's having improved upon his or her past performance. Because high-, average-, and low-achievers are equally challenged to do their best, the contribution of each team member is of equal value.

Cooperative Learning Outcomes

After an analysis of over 70 research studies of cooperative learning, Slavin (1989) concluded that cooperative learning is an effective alternative to traditional teaching methods. Of 63 studies in which academic achievement was measured, 57% found significantly greater achievement than control groups, while 41% found no statistical differences, and only one study found the control group outscoring the cooperative learning group. When Slavin limited the studies to those in which Student Team Learning principles were followed, he further concluded that 34 out of 41 such studies (83%) found significantly positive achievement results.

An underlying aspect of cooperative learning is a building-social-skills component. By designing appropriate activities, the cooperative learning teacher can teach social skills to the students at the same time that content is being taught (Lyman, Foyle, & Azwell, 1993). Haring-Smith (1993) pointed out that real-world jobs require workers to cooperate. She went on to assert that cooperative learning teaches students how to work together in a group, instead of competing against each other. Further, cooperative learning students develop "considerable commitment and caring for each other," according to Johnson and Johnson (1991).

Additionally, Slavin (1990) asserted that cooperative learning improves intergroup relations, encourages acceptance of mainstreamed academically-handicapped students, builds self-esteem, and improves time on task.

Computer-Mediated Cooperative Learning

Traditionally, cooperative learning assumes that the group's members are working together in the same location and at the same time under the watchful eye of the instructor. The system proposed here—Computer-Mediated Cooperative Learning (CMCL)—allows the students and teacher to be remote from one another in both space and time. As proposed here, CMCL draws on the dictates of cooperative learning, while using computers to provide a true cooperative learning experience. As described below, CMCL assumes that the computers will be networked with e-mail capabilities and access to the Internet. There are two components or modules to CMCL, one for the teacher and another for the student. The teacher's module provides access to tools that enable the teacher to set up, monitor, and supervise the groups or teams. Similarly the students' module provides tools that enable students to communicate with fellow group members and the teacher, establish group goals, monitor the group's progress, access remote Internet sites, and prepare the group's final product.

Because CMCL may or may not take place within a traditional classroom setting, the number of students per group, as well as the number of groups, may not seem to be as constrained as in traditional cooperative learning. However, for the same reasons that traditional cooperative learning limits the number of students per group to six or fewer, it is suggested that the size of CMCL groups follow the same guidelines. The number of groups may not be as important a consideration, except that a large number of groups working simultaneously may have an impact on the teacher's ability to monitor each group's progress sufficiently.

The Teacher's Screen

As seen in figure 1, the teacher's screen is divided horizontally into three basic areas: actions, options, and information.

FIGURE 1
See Appedix C of the *1996 AECT Proceedings*

As the cooperative learning project proceeds, there are essentially three different activities the teacher must complete: preparing the assignment for the students, monitoring their progress, and communicating with them on an ongoing basis. On occasion, the teacher may also need context-specific help about the various functions of the CMCL system. Hence there are buttons in the action area for each of these activities. Once an action has been selected, there are then several subordinate actions to be chosen from; hence the options area. The entire right-hand side of the screen is devoted to an area for providing information, both textual and graphical, relative to each of the actions and options. Below the information area is a control panel providing additional buttons for processing the information.

In addition to the three areas discussed above, the teacher's screen also has a message alert indicator in the upper left corner and a calendar/clock indicator in the upper right corner. Details and possible functions of these two indicators will be described later.

Preliminary preparations. Before the CMCL experience can begin, the teacher must first decide upon overall general goals for the groups (see figure 2). The teacher first composes specific directions in terms of the mechanics of the activity: the length and format of the final product, due date(s), grading procedures, and the like. Additionally, the teacher prepares suggestions for the students to use when they are in the various phases of the activity (planning, scheduling, preparing and revising drafts, examining Internet sites, and publishing the final report). Because the preceding preparatory work may be generic in nature, knowledge of the specific topic may not be needed. Indeed, many of the suggestions could be incorporated into the software package itself.

FIGURE 2
See Appedix C of the *1996 AECT Proceedings*

The next step in the preparation stage is to choose a topic for the group (CMCL permits the teacher to assign a different topic to each group if desired). At this point, the teacher may want to add to some of the directions listed above, making them more topic specific or more student specific. For example, depending on the topic, the teacher may have specific suggestions for dividing the material into subtopics for individual team members. The teacher may want to tell a particular group to be sure to include this area or avoid that area, or he or she may want to provide specific instructions for a particular student based on prior knowledge of that student's interests and capabilities. The teacher may also want to explore the Internet to find appropriate sites for a particular group to access. As seen in figure 2, the options area of the teacher's screen contains buttons to provide the teacher with the tools necessary to compose directions and suggestions for the students. CMCL would then make all of this information available to the students, possibly by downloading it to each student's computer, from a central server, or across the Internet.

Team building. After the preparations as described above have been made, the teacher is ready to build the teams. Having entering the students' names (and other student-specific information if desired) and specifying the number of teams, the teacher is presented with the screen shown in figure 3.

The options area now contains a list (scrolling if necessary) of the students, and the information area contains a rectangular box or container for each group (again scrolling if necessary). The teacher drags a name from the list into the appropriate box, at which time the name is removed from the list in the options area. This operation proceeds until all the names have been placed in containers. It is also possible to drag a name from one container to another. When the teacher has built the teams, he or she clicks on the "done" button in the control panel area. Appropriate messages would warn the teacher if any students hadn't been placed in a group, or if the pre-specified group size had been exceeded (in either case, the teacher would have the option of overriding CMCL's concern).

FIGURE 3
See Appedix C of the *1996 AECT Proceedings*

If the appropriate information were available, CMCL may also provide options for displaying individual team members grades and the team's grade average to date. Different colors may be used to indicate whether a particular student is a high-, middle-, or low-achiever. With all this information readily available and easily displayed, the teacher could manipulate the groups' composition to guarantee the heterogeneity dictated by most traditional cooperative learning constructs.

Message center. Because communication among team members and between the team and the teacher is so vitally important for cooperative learning, CMCL has a message center built into it. Both the teacher and the students have access to the message center for sending and receiving messages. The teacher's message center (see figure 4) uses the options area to display a list of the teams and their members.

FIGURE 4

See Appedix C of the *1996 AECT Proceedings*

This list is expandable and collapsible so that lists of one or more teams' members is displayed, or only the list of teams is displayed. By clicking on an individual student's name, the teacher is presented with a list of messages received from and sent to that student. Previously-read messages, as well those to which a reply had been sent may be indicated (using symbols or colors). Double-clicking on a particular message line displays the entire message. Similar to the functions of most e-mail systems, the buttons in the control panel at the bottom enable the teacher to compose new messages, reply to received messages, forward messages to other students, print messages, archive or delete messages, and so forth. The teacher also has the option of selecting more than one student or even entire teams from the list for the purpose of sending the same message to more than one student at a time. It is also through the message center that the teacher receives drafts and final reports from the teams.

Activity reports. Some cooperative learning methods such as Group Investigation require that the teacher evaluate an individual student's achievement by examining the student's higher-order thinking skills (Sharan & Sharan, 1976). By overseeing the students as they work in their groups, the teacher may observe and evaluate the student's work habits, grasp of the subject, thinking processes, and the like. With students working individually at computers possibly remote from the teacher, such evaluation is decidedly more complicated. It is for this reason that CMCL has an "activity reports" function built in (see figure 5).

FIGURE 5

See Appedix C of the *1996 AECT Proceedings*

As students go about their various activities, CMCL keeps track of what the students are doing on the computer. A built-in monitoring system records which activity the student has selected (from the actions and options available to him or her), the date of the activity, and the length of time spent on that activity. When appropriate, CMCL records additional information such as the uniform resource locator (URL) address for any Internet site accessed, details for any messages sent and received, contents of the student's and team's notebooks (discussed in detail later), and so forth.

When the teacher selects "Activity Reports," he or she is given the same expandable/collapsible list as before with a listing for each team and each student. Clicking on a student's name displays a summary report of that student's activity which can then be expanded further to reveal the individual activities. The teacher can then select an activity from that list and examine any additional details in the report (by clicking on the "Details" button in the control strip). Armed with the content and sequence of a student's activity, the teacher should be better able to evaluate that student's progress at any stage of the cooperative learning assignment. Granted, the "time spent" as recorded in an activity report is not necessarily time on task, but the teacher does at least know that the student did indeed engage in that activity for some length of time. It is hoped that the entire scope of a student's activities will form an accurate picture of what the student has done.

The Student's Screen

The layout and general function of the student's screen is similar to that for the teacher (see figure 6). It too is divided horizontally into the same three areas: actions, options, and information.

FIGURE 6

See Appedix C of the *1996 AECT Proceedings*

Message center. The student's message center functions in a manner similar to that for the teacher. Messages can be sent to and received from fellow team members and the teacher. Depending on the nature of the assignment, the teacher can also enable messaging between members of different teams as well (since some forms of cooperative learning support intergroup collaboration, while others do not).

Examine assignment. With this function, the student is able to examine the preparatory information that the teacher has supplied (see figure 7).

FIGURE 7
See Appedix C of the *1996 AECT Proceedings*

A collapsible/expandable list of subjects appears in the option area. Clicking on any one displays the teacher-prepared material in the information area. It is here that the student has access to the generic instructions, as well as specific instructions directed toward the topic, the team, or the individual student. The control panel contains buttons for processing the information (printing, saving, and the like).

Plan & schedule. Perhaps no other area of traditional cooperative learning relies as much on the team members' being together as does the planning and scheduling phase of the project. Relying on an awareness of each other's strengths and weaknesses, team members working in person can negotiate precisely who is going to do what and when. Because the team members in CMCL may or may not know each other, may or may not be able to physically meet as a group, CMCL relies on the messaging system for planning and scheduling. After one student is selected from the group, either by the teacher beforehand or by the group via the message center, the teacher activates the planning and scheduling controls for that student alone (see figure 8).

FIGURE 8
See Appedix C of the *1996 AECT Proceedings*

After selecting "plan" from the options area, the designated student is presented with a list of tasks to be completed by the group. The teacher will have already prepared a list of required tasks, as well as list of optional tasks. After consultation with the other team members (via the message center), the designee may add additional tasks to the list by means of keyboard entry. These three different kinds of tasks (required, optional, and student-generated) may be signified by different colors for ease of identification. The student uses a click-and-drag technique (similar to that that the teacher had previously used to assemble the groups) to place the tasks into the team members' boxes. As before, tasks can be moved from one box to another. It is assumed that this division of labor is accomplished after considerable discussion (via the message center) among the group's members. (An alternative to having a designated student assign the tasks would be to have the teacher fill this role. This functionality would then have to be added to the teacher's module.)

After the tasks have been assigned, the student clicks on the "Done" button in the control strip and the task assignments are recorded by the system and made accessible to the other team members. (If any required tasks had not yet been assigned, CMCL would respond with an appropriate message.) The other team members then have the ability to look at the task assignments, but not alter them (prior to that time, any attempt by the other team members to access the planning windows would be met with an "in progress" message). The original designee retains the ability to alter task assignments (move, add, and remove), with the agreement of the group of course. The list of task assignments is available to the teacher through the activity report for the team.

Scheduling proceeds in a similar manner. When a student selects the scheduling option, his or her list of tasks is displayed in the options area. The information area displays a calendar with the teacher-imposed deadlines. The student then drags each task to a box in the calendar. Attempts to place tasks beyond relevant deadlines is met with appropriate warning messages. As with planning, the student can choose to alter the schedule at a future time. A student's schedule is available to the teacher through that student's activity report.

Examine sites. The heart of CMCL is the student's ability to examine sites on the Internet. By clicking on the "Examine Sites" button, the student is given two options: searching the Internet or looking at teacher-suggested sites (see figure 9).

FIGURE 9
See Appedix C of the *1996 AECT Proceedings*

CMCL can provide either a keyword search or a content search, possibly using the search engines and content lists already available on the Internet. The interface for this activity is similar to that used by such popular browsers as Netscape and Mosaic. (Although students cannot easily be prevented from conducting irrelevant searches, the absence of buttons such as "What's Hot" and "Cool Sites" may help.) Clicking on "Suggested Sites" displays the sites that the teacher had previously entered into the system. Again, the display is similar to the list generated by a search in Netscape or Mosaic. Clicking on any listing opens the URL for that listing.

The "Save Site" button in the control strip allows the student to save the site's URL to the student's personal notebook for future reference. While examining a site, a student can select text or graphics to be placed in the student's personal notebook as well. Clicking on the "Save Item" button copies the selected text or graphic to the notebook, downloading the file if necessary.

Prepare draft. After the student has gathered information from the Internet, it is time to prepare a draft of his or her portion of the final project (see figure 10). Both the information gathered and the draft itself are saved in the student's personal "notebook."

The "Site List" button permits the student to easily return to the previously-saved URL's on the Internet at the click of the mouse. The "Saved Items" button functions as a "library" of saved items. As with libraries in many software programs, a CMCL library can be viewed an individual item at a time or as a scrolling list of so-called "thumbnails" (abbreviated versions of text items and miniature representations of graphic items). Clicking on a thumbnail displays the complete item.

The "Draft" button enables the student to assemble the results of his or her efforts into a document. Depending on the sophistication and abilities of the students, as well as the nature of the final product (as determined by the teacher), the draft mode may function like an integrated software package such as Microsoft Works®, as a presentation program such as PowerPoint®, as a page layout program such as PageMaker®, or as a web page creation program such as PageMill®, for example. Ideally, this functionality would be built into the CMCL system, but realistically, it may be more efficient to link to a dedicated program instead. Regardless of which route is taken, the student should have full use of appropriate tools for composing and editing text and graphics.

FIGURE 10
See Appedix C of the *1996 AECT Proceedings*

Upon completion, the student can send the draft to fellow team members and the teacher for comment. Using an annotation system similar to that in Microsoft® products, the draft reviewer can attach collapsible Post-it™-like notes to the draft ,which can then be expanded upon receipt by the student who prepared the draft. As computer systems attain increased speed and memory, such annotation might include digitized audio and video from the reviewer.

Publish report. As with the planning phase of the project, the publishing of the final report is prepared by one member of the group, determined in advance during task assignment. As might be expected, this student takes the revised drafts from the team members and assembles them into a coherent whole using the same document preparation package as before. Once again, the draft of the final product is shared with the team members and the teacher for comment, using the same annotation system as before. The culmination of this cooperative learning experience is sharing the final product with the rest of the teams via the network.

Miscellaneous Features

The "message alert" indicator in the upper left corner of both the teacher's and student's screens may be configured to function in several ways. For example, it may display the number of unread messages, it may flash to indicate that a message has just been received, or it may turn a certain color to indicate that there is an unread message from the teacher.

The "date and time indicator" may likewise be used to display pertinent information for a student. For example, clicking on it may display the amount of time since the person first logged on for the current session, it may display the total amount of time that the person has spent on the project, or it may turn a progressively more intense color as a deadline approaches.

The "Help" button should be context sensitive. It may be configured to provide so-called "balloon help": as the user drags the cursor around the screen, cartoon-like balloons appear explaining the function and features of the item the cursor is currently over. Help may also be set up to display a list of topics that are applicable to the user's current situation. Clicking on any item in the list provides further details.

Likely Problems

The hardware and software requirements for CMCL do not come cheaply. It is expected that each student will have the availability of a fast machine with a large monitor (17≤ minimum) and connections to a local area network, a high-quality printer (preferably color), and the Internet. As with many computer-mediated projects, the technology often takes center stage when problems arise: things aren't connected properly, equipment simply doesn't work, network connections are lost or disabled entirely, students don't know how to operate certain functions of the computer or the software, and so forth. Consequently, the availability of a technician familiar with both the hardware and software is desired.

In light of recent publicity about the availability of pornography on the Internet (Elmer-DeWitt, 1995; Rimm, 1995), many teachers, parents, and students are concerned—justifiably or not—about this aspect of using the Internet. It is therefore assumed that the teacher will at the very least disable searches using words in a predefined list of objectionable terms. It is further hoped that the teacher will use one of the emerging commercial products for blocking access to objectionable sites.

The right of privacy may be another potential concern for some students. Because the teacher will be able to look at a log of each student's activities (sites visited, e-mail messages sent, and the like), it is important that students (and their parents) be made well aware of this feature at the outset. However, the student must not be made to feel that "Big Brother" is watching. The teacher has a legitimate concern for wanting to see this information: he or she needs such information to accurately judge a student's intellectual growth and academic achievement.

Because students may not have the direct, in-person supervision of the teacher, CMCL may be set up so that students are required to complete their work in a logical sequence. For example, they can't prepare the final project before they have divided the tasks and visited some sites. CMCL can be configured so that certain functions are not available (indicated by dimmed buttons, for example) until certain other functions have been given enough attention (assignment of all the tasks, a pre-specified amount of time spent on a certain activity, or a pre-specified number of sites visited, for example).

Performing a certain activity within CMCL may be more time consuming than conducting that same activity in an actual face-to-face meeting. For example, dividing the task assignments requires a fair amount of negotiation, and sending e-mail messages back and forth can slow down this process considerably. If the students are all in the same classroom, there is no reason why they can't complete some activities in person before entering the information into the system.

Closing Comments

CMCL requires both teachers and students to rethink how teaching and learning take place. It puts an additional burden on the teacher, particularly in terms of preparation and evaluation. Drawing upon the research on cooperative learning and Student Team Learning in particular, CMCL has the same potential for enhancing the learning experience. In addition to using certificates and the like for team rewards, the teacher may also publish the best final products on the Internet. Because each student is responsible for producing his or her own part of the final document, individual accountability is maintained. Finally, because the teacher can monitor an individual student's improvement and offer guidance when necessary, CMCL provides all students with equal opportunities for success.

Since cooperative learning relies so much on the interpersonal relationships among a group's members, it is reasonable to question whether or not learners seated at their own computers—possibly remote from one another, as well as remote from the teacher—can have the same rich, social experience that a group seated at the same table can have. CMCL, especially through the use of the message center and the activity reports which enable the students and teacher to be in constant contact with one other, develops a new kind of group dynamic, but one which has the potential for an engaging and productive social experience.

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Title:

Integrated Research On Learning From Television

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The body of research literature on learning from film and television is voluminous. There are many documents which synthesize specific aspects of this literature, but none which cover both major streams of research, mass media and instructional television. This study reports a major synthesis effort that integrates both sources of research. The body of literature reviewed encompasses 17,500 citations from the Educational Resources Information Clearinghouse (ERIC) and 1,882 citations from Psychological Abstracts.

The methodology selected for this review is integrative research as described by Harris M. Cooper (1989). This methodology was selected because it enables the researcher to summarize past research by drawing conclusions from many separate and diverse studies. This method requires completing five stages in such a manner as to ensure that sources of invalidity are controlled.

The first stage is problem formulation in which definitions are formed which distinquish relevant and irrelevant studies. The major source of error at this stage is not starting broadly enough and focusing too early on narrow concepts and superficial details. The second stage is data collection in which sources of potentially relevant studies are identified. The main sources of invalidity at this stage are that studies and samples may differ from the target population, in the case the body of literature identified. The third stage is data evaluation in which criteria are formulated and applied to distinquish valid from invalid studies. At this point invalidity can arise from inclusion of studies with flawed research. The fourth stage, analysis and interpretation, deals with synthesizing the body of literature identified as representative and methodologically defensible. Invalidity can result from unwarranted inferences from extraneous data or variables or from synthesis assumptions that are wrong. The fifth stage is presentation which allows the researcher to use visuals to describe logical relationships across the data. The sources of error may include omission of review procedures or findings. The use of visuals and presentation strategies enhances the synthsizing process.

A comprehensive historical review of television research revealed two parallel strands which evolved separately. The first of these which was related to education and psychology began in the 1950's with comparative media research, evolved into media effects and individual differences and is represented today by research on interactions from viewer characteristics and television effects. The parallel strand originated during the 1960's in research related to mass media and social effects and formal features.

This historical review yielded the major categories of the television viewing system. This television viewing system concept was present in the literature as a way to explain the totality of the television viewing experience. Research evolved around the three components of this viewing system: programming, environment, and behavior. Figure 1, TV Viewing System, illustrates the components of the viewing and the research areas associated with each. The programing and environment components represent independent and mediating variables respectively; while behavior represents dependent variables.

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Figure 1. TV Viewing System

After the literature was analyzed from the point of view of the television viewing system, a number of major research areas became apparent. These were:

- •message design and cognitive processing
- •school achievement
- •family viewing context
- •attitudes, beliefs, behaviors
- •programming and utilization
- •critical viewing skills.

The problem was reformulated as reviewing and synthesizing research in these areas.

The next step was data collection. Classic, representative, and pivotal studies in each area were identified through review books and documents, computerized searching, and indexing of relevant articles from journals in the field from the 1960's on. Original documents were obtained and studied. Extensive files in each area were organized, and cross referencing was done.

Each of the authors of this paper choose different areas in which to begin the next step, data evaluation. In addition to summarizing findings, each author was to identify methodological problems in individual studies and across the literature. Seriously flawed or inconsequential studies were withdrawn from the population of studies.

Several methodological problems were identified across the research areas. Operational definitions varied between psychologists and educators and even between individual psychologists or between individual educators.

Conclusions of laboratory studies were inferred to apply to realistic settings. Confounding variables in field and home settings were not controlled or in some cases even recognized. Different variables were studied at different ages which made comparison and synthesis impossible beyond one age level. There was an over-reliance on self-reporting methods throughout most of the research.

When data evaluation in each of the areas was complete, an analysis and interpretation was done for each area and then for the whole study. Conclusions for each area were summarized, and recommendations for future research were prepared. Then, the authors analyzed and interpreted the data of the whole study. To do this several assumptions were made:

- causality statements must be well-supported
- substantive conclusions from each area should remain separate
- methological conclusions from each area could be integrated, and
- graphic comparisons among areas would be helpful.

The authors began with group editing of the summaries and conclusions then proceeded to graphic comparison.

The first comparison was done by listing the research-based conclusions in one column and general misconceptions in the other column. The second comparison required a table which related the research areas with the specific variables addressed throughout the research. Table 1, Research Areas and Variables Addressed in Specific Areas, is the result of this comparison.

The next graphic comparison concerned the identification of dominant research methodologies in the various research areas. From this representation it is clear that certain methodologies have been heavily used to address a variety of research areas while other methodologies appear not to have been used in an area. The areas where these other methodologies have not been used may provide fruitful research opportunities which would strengthen the research in each area. Few research areas have benefited from the use of all methodological approaches. This comparison is shown in Table 2, Research Methodologies Employed in the Various Research Areas.

Variables	CATEGORIES					
	Cognitive Processing	School Achievement	Family Context	Socialization	Programming Utilization	Critical Viewing
Attention	■	■			■	■
Comprehension	■	■	■		■	■
Reading Ability	■	■				■
Imagination		■	■		■	■
Viewing Environment			■	■		
Coviewing			■	■	■	
Viewing Habits		■	■	■	■	■
Attitudes			■	■	■	■
Behavior			■	■	■	
Beliefs			■	■	■	■
Programming	■	■	■	■	■	■
Utilization		■	■		■	
Critical Viewing	■			■	■	■

Table 1 Research Areas and Related Variables

Research Areas	METHODOLOGIES			
	Experimental	Qualitative	Descriptive	Developmental
Early Studies	■		■	
Message Design	■			■
Cognitive Processing	■			
School Achievement	■		■	
Imagination	■	■		
Viewing Environment		■	■	
Coviewing	■	■	■	
Viewing Habits	■	■	■	
Attitudes	■		■	
Beliefs	■		■	
Behavior	■	■	■	■
Programming	■		■	■
Utilization	■		■	
Critical Viewing			■	■

Table 2 Methodological Approaches and Research Areas

The last graphic technique used for synthesis was employed to identify the relationship of instructional technology practioners to application of the research on learning from television. The technique used was to separate in boxes the roles assumed and the tasks subsumed under role. This analysis is presented in Figure 2, Roles of the Instructional Technologist.

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Figure 2. Roles of the Instructional Technologist

The last stage of the integrative research process was public presentation. The presentation of the findings highlighted selected conclusions in each of the major research areas: message design and cognitive processing, school achievement, family viewing context, attitudes, beliefs, and behaviors, programming and utilization, and critical viewing skills. The presentation included an explanation of the research process used in this study. In addition, methodological sources of error were identified and summarized. Future directions for research related to television effects were presented. These were:

- examine long term/cumulative effects
- conduct more naturalistic studies
- research effects of prosocial programming
- identify societal variables which interact with television effects
- encourage causal research related to television and behavior.

The complete results of the study will be published as Chapter 11, Research on Learning from Television in *Handbook of Research on Educational Communications and Technology* (in press).

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Title:

A Conceptual Framework and Procedure for Message Design

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Every day we are bombarded with messages. Our minds sift through the thousands of signals we receive and chooses which ones we pay attention to, which ones we remember for a short period of time, and which ones go into our long-term memory. Such message bombardment exists in the form of advertisements on a radio, posters on a bus, news on television, directions on a box of brownie mix, letters retrieved from e-mail, and a warning on an antihistamine package. The mind must sift well in order to weed out the many other messages we receive that are unimportant.

It is not surprising, therefore, that when a message is intended to be instructional, great care must go into planning for the content and form that will attract attention and facilitate perception, comprehension, and retention. An instructional designer or developer uses research and theory to produce a message that retains attention and results in learning. To do this, the designer or developer draws on theory from many fields including:

psychological and learning theories which provide principles related to outcomes
communication and systems theories which provide process models
aesthetic principles which provide guidelines for graphic design and cuing.

Since the 1950's, one journal has continuously published articles on message design. This journal is *Educational Technology Research and Theory* formerly *Educational Communications and Technology Journal* and *Audiovisual Communications Review.* Many books have addressed the topic including Berelson & Steiner, 1964; Fleming & Levie, 1978; 1993; West, Farmer, & Wolff, 1991; and Tufte, 1983;1990. The *Handbook of Research on Educational Communications and Technology* (Jonassen, in press) devotes several of its 42 chapters to principles related to the design of messages including chapters on:

Behaviorism and Instructional Technology
Cognitive Perspective in Psychology
Research on and Research with Emerging Technologies
Visual Literacy
Visual Message Design and Learning
Text Design
Multiple-Channel Communications
Instructional Technology and Attitude Change

One consequence of these multiple sources of research and theory is designers who are overwhelmed by an abundance of principles and guidelines because they do not have tools to facilitate taking many variables into account concurrently. Despite the voluminous research published and the numerous models, concepts, and theories hypothesized, there is little to help the designer understand and apply this work because conceptual frameworks which illuminate relationships among message design variables are inadequate.

Furthermore, the art of message design has been practiced with the tools of another age. Paper and pencil are fine tools, but their use is limited. Working in the field of instructional technology, one cannot avoid wondering when the technology will be applied to the field itself. Efforts have been made to automate design including message design. Richey (in press) reviews trends in research on automated design tools and the practicality of such tools. Powell and Okey (1994) discuss the role of performance support in multimedia authoring. Merrill and his colleagues have developed Instructional Transaction Theory which addresses instructional strategies as well as message design (Merrill & ID2 Research Team, April,1993; Merrill, Jones, & Li, June,1992). Issues of evaluating automated design have been raised by Gros and Spector (1994). Nevertheless, no commonly accepted automated procedure for message design has been produced.

Our goal was to develop a conceptual structure that would lead to an improved process for message design by making relationships among variables clearer; thus, theories from diverse sources would become more manageable. To develop this conceptual structure and process, many issues had to be resolved. The process was evaluated formatively as the structure was being developed.

The ideas presented here are seen as an initial step in developing an electronic performance support system (Witt & Wager, 1994; Gery, 1993; Stevens & Stevens, 1995) for designing messages. When combined with the work of others, such as the work of Keller and others on motivation (Keller & Burkman, 1993; McAleese & Gunn, 1994) and the work of Boling (1995; 1994) on screen design principles, this conceptual structure could become part of a computerized tool to support message design. Even if that progression does not occur, results from formative evaluations substantiate the value of the conceptual structure as a base for procedural theory which disciplines and guides designers. The purposes of this research are (1) to develop a conceptual framework for message design, (2) to develop a systematic procedure for message design, and (3) to provide one basis for the development of a performance support system.

The Theoretical Base for Message Design

Since the 1960's researchers in instructional technology have pursued the goal of a theoretical base for message design. This goal has been elusive despite (a) the synthesis of research into principles, (b) the extension of principles in areas such as motivation and concept learning, and © the increasing availability of tools for the design of messages and researching message design. In 1962 an issue of *Audiovisual Communication Review* was devoted to the relationship of perception theory to the design of audiovisual messages (Norberg, 1962). As early as 1963 a definition of the field described instructional technology as the study and practice of controlling messages (Seels & Richey, 1994). All of the articles in the July-August 1963 issue of *Audiovisual Communications Review* addressed message design because the issue included articles on the use of pictures, repetition in educational television, opinion change as mediated by film, effectiveness of films with indirect presentations, and pacing in programed instruction.

Berelson and Steiner (1964) culled principles from psychology that could help the behavioral scientists in a variety of roles. Fleming and Levie (1978) extended the work of Berelson and Steiner but directed their book towards instructional planners, such as message designers. Fleming and Levie's first edition had a great impact on the field as documented by the number of reviews (Markle, 1979; Borich, 1979; Clark; 1979) that appeared at that time and the awards presented to the authors by the Association for Educational Communications and Technology and the National Society for Performance and Instruction. The term message design was used in the literature frequently thereafter.

Research in diverse areas, such as cue summation, concept formation, animation, and attitude change, followed and contributed to a growing knowledge base. In 1991 West, Farmer and Wolff synthesized principles from the cognitive sciences especially as they related to frames or visual representation of content relationships. The second edition of Fleming and Levie's book appeared in 1993. It reflected advances in research and theory and included chapters which covered additional learning outcomes. The second edition also substituted a chapter on learning strategies for principles of memory learning. The second edition was well received (Allen, 1993); although the impact seems to have been less than with the first edition based on the number of reviews published.

Grabowski (1995) and Berry (1995) have written articles which trace the evolution of message design as an area of study and practice. Grabowski reviews major contributors to theory about message design and explains how the concept of mental processing or "inductive composition" has been added to the concept of planning for the physical form of the message. Berry describes the area of message design as becoming increasingly focused on circumscribed, specific messages, such as individual visuals, computer-based instruction sequences, and pages or screens. Thus, current research is directed more towards visuals and their processing than towards programs or speeches.

Although the concept of message design has been evolving since the 1960's, the first problem encountered while developing this conceptual structure was defining message design. Several questions about the nature and scope of message design arose:

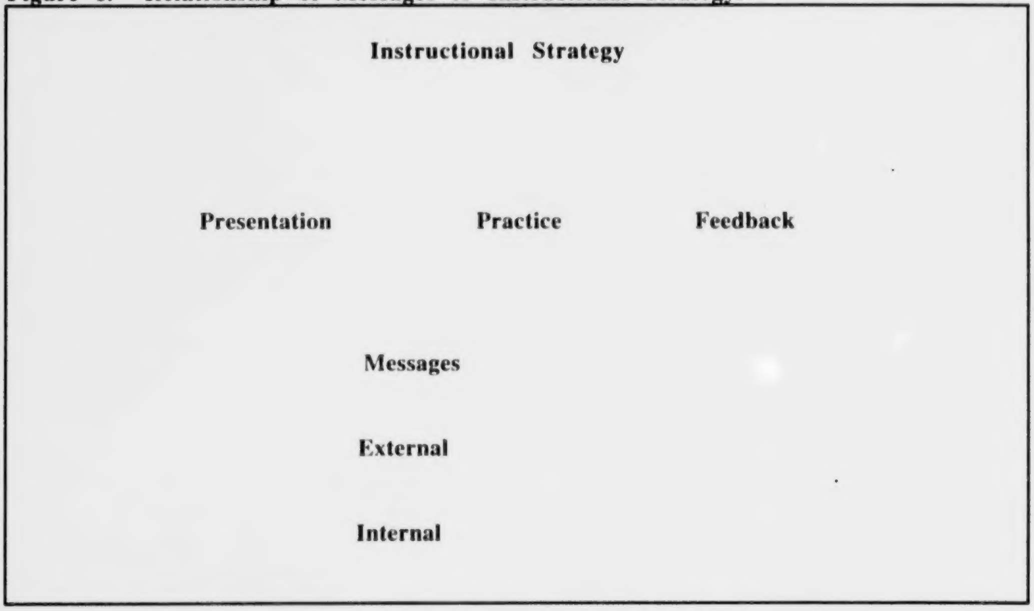
What constitutes a message?
What does the message design process encompass?
What is the difference between instructional strategies and message design?

We will address each question and its resolution in order.

Both editions of the books by Fleming and Levie (1978, 1993) describe a message as "a pattern of signs (words, pictures, gestures) produced for the purpose of modifying the psychomotor, cognitive, or affective behavior of one or more persons (1978, p. x)." According to Grabowski (1995), external factors relate to message design for instruction and include dealing with attention, perception, and comprehension. Internal factors relate to message design for learning and include dealing with retention and retrieval.

What then is message design? The various definitions have in common planning for the form in which the message should appear. According to Seels and Richey (1994), "Message design encompasses principles of attention, perception, and retention that direct specifications for the physical form of the messages which are intended to communicate between a sender and a receiver (p. 31)." When message design is compared with instructional strategy design, it becomes clear that the construct "instructional strategy" differs from the construct "message design" by encompassing all the steps in lesson design rather than just the ones related to presentations. "Instructional strategies are specifications for selecting and sequencing events and activities in a lesson"(Seels & Richey, 1994, p. 129)."

Figure 1. Relationship of Messages to Instructional Strategy.



We concluded that message design addresses only the presentation part of an instructional strategy and is focused on specifications for patterns of signs and symbols developed by a designer or learner. This definition puts the emphasis on one part of the instructional process, the external or internal form of a presentation. This relationship is illustrated in Figure 1. Notice that the presentation part of an instructional strategy can incorporate many messages.

This study needs to be interpreted using this definition:

Message design *is planning for the physical form of the presentation part of an instructional strategy and for the symbolic form in which a message is to be stored in memory.*

It was decided that this study would focus on developing a procedure for designing the presentation part of a message. Because the symbolic form for storage is under the control of the learner, it is not predetermined.

Figure 2. A Message Design Problem on Bicycle Safety

A unit on bicycle safety is being designed for second graders at all elementary schools in a suburban middle class district. The unit was prompted by the state's new helmet law for anyone riding a bicycle. It will be team taught by teachers from several subject areas including physical education, social studies, science. The teaching team is reviewing materials and approaches from many sources in order to determine the nature of the unit.

The objectives for the unit represent different types of goals: informative, attitudinal, conceptual, and psychomotor. The design team has decided that students need (a) knowledge, such as the safety equipment required, (b) attitudes, such as respecting safety laws, (c) concepts, such as procedures for safe operation of the bicycle, and (d) motor skills, such as braking and turning.

Thus, unit or lesson objectives could relate to:

identifying safety features on equipment
valuing wearing a helmet
obeying laws when operating a bicycle
demonstrating how to stop a bicycle when riding

Many other objectives could be derived from the goals of the teaching team. Some of the initial elements that the team has decided to incorporate in the unit are:

There will be a mock street environment created on the parking lot.

An existing computerized driver's test will be used.

A new computer program on the parts of a bicycle will be created.

An information booklet or handout for parents will be produced by second graders. This booklet will summarize the parent's responsibilities and the child's responsibilities and may include a contract.

An assembly program with a speaker's script and visuals will be incorporated.

The design team's research has revealed several useful sources of content, materials and activities.

The AAA (American Automobile Association) provides a brochure on bicycle safety laws and other materials.

The American Academy of Pediatrics has an injury prevention program called "tipp" that offers advise for parents including guidelines on bicycle use and maintenance. The "tipp" program also provides a bicycle driver's test for young riders that parents can administer.

A local Youth Cycle League offers to conduct safety awareness activities, such as assemblies, instructors, and bicycle activity days with mock driving tests.

The local police also offer these activities.

A national cycling association offers reprints from its magazine "Bicycle Forum." Reprints of articles from this magazine are available through a local cycling club called "The Wheelman." This local club has a monthly newsletter that stimulates interest in serious cycling, a telephone hotline of cycling news, and a web site for cycling enthusiasts.

Design an instructional message that will facilitate achievement of a lesson objective. Follow the procedure for theory-based message design.

The Research Process

The research process used was formative evaluation (Seels and Glasgow,1990; Flagg, 1990; Tessmer, 1993). The formative evaluation techniques differed depending on the phase of development and the stage of formative evaluation. In the beginning, focus groups of advanced instructional design students explored message design procedures and relationships using the traditional steps for the use of such groups (Stewart & Shamdasani, 1990).

The first focus group began by concentrating on how to evaluate the thoroughness of the message design process. The group recommended a checklist based on a design template presented in West, Farmer, and Wolff (1991). It proved too long and too broad to allow the designers to focus on the detail necessary in message design. The time spent on needs assessment, specification of objectives, and instructional strategy established a complete context for the message at the expense of time spent on planning and specifying details. This original checklist also incorporated reference to lists of principles on message design which overwhelmed the designer. Teams within the focus group tried out the procedure by designing messages for different types of learning. The solutions were then subjected to expert review and revision.

The next focus group addressed how to condense these variables The group recommended a one-page template to summarize factors such as context, constraints, learner characteristics, outcomes, content and media. Originally this template included both outcomes and types of learning. Eventually these were merged. The factor of paradigm considerations was included on the template but was developed as a separate step based on data from tryout. Based on recommendations for revision, the template became a design aid but was eventually disregarded as other design aids were created which replaced it.

Many worksheets were developed and discarded. After try-outs, such as using a long worksheet to develop a message to change attitudes, it became clear that they were impractical. Long worksheets overwhelmed the designer particularly when used before a few important decisions were made. This focus group also decided that motivation and perception were learning outcomes basic to all other types of learning. Thus, these were separated from other types of learning, and a procedure for designing for these outcomes was incorporated in the process.

One of the last steps in the research procedure was to develop a simulation exercise requiring application of the procedure to solving typical message design problems. Students in advanced instructional design classes used this exercise individually and in teams to practice the procedure while being observed by the developers who recorded difficulties with the procedure. A motivational message on wearing a helmet for safe cycling was designed using the procedure, piloted, and discussed. The bicycle example which proved so flexible and easy was used with variations for exercises and examples with different focus groups. An example of the bicycle exercise used in the tryouts is summarized in Figure 2. Individuals in these focus groups also submitted reaction forms and notes in margins of the exercise.

As the procedure was evolving, many forms for visualizing the related conceptual framework were considered including concentric circles and a scattergram. Eventually, decision trees in various forms including hierarchies were used to represent both the conceptual framework and procedure for message design. The process became more complex than decision trees could represent. Therefore, late in the research process it was decided that an oval diagram could be used to identify the interactions among variables. Some conventions from objective tree diagraming were combined with oval diagraming (Delp, Thesen, Motiwalla, & Seshadri,1977) to show how variables impinge on message design. From this basic visual, the final conceptual framework emerged.

The Conceptual Framework

Because there is little theory that suggests ways to interrelate variables, such as aesthetics, learning requirements and situational factors, most message design is done by developers using creativity and principles of systems design. Few designers are involved in message design based on learning or other principles. Instructional designers could prepare specifications for messages based on theory drawn from several areas of research if both conceptual and procedural theory were available. A proposed conceptual framework is shown in Figure 3. The major variables identified are learning types, parameters, paradigms, motivation, perception, and design principles. Although all these variables are interrelated, dotted lines are used to show those which have the closest relationships.

Figure 3. A Conceptual Framework for Message Design

See Appendix E of the *1996 AECT Proceedings*

A Theory-Based Procedure for Message Design

This procedure is intended for competent instructional designers or developers. It is not intended as a teaching tool. The results of formative evaluation indicate that it is an effective procedure for practioners because it disciplines them to be systematic and cues them to attend to variables in specific ways.

Figure 4. A Flowchart of the Theory-Based Procedure

See Appendix E of the *1996 AECT Proceedings*

This procedure requires using a series of design aids which suggest principles that may be important to your message. None of these design aids offers all the principles in an area. You can also consider principles you know are important or consult sources. The design aids serve to cue your attention to areas.

As the framework shows, the order in which you address the major variables can vary; however the procedure given recommends an order that the research revealed was generally most effective. This order is given in Figure 4. Notice that the first step is to describe the purpose for the message and the creative idea under consideration. The final product is the Message Design Worksheet which summarizes the design plan. An example of this final product is given in Table 1.

There are six design aids incorporated in the procedure. Each highlights some of the principles that need to be taken into account when designing for different types of learning. Identify the type of learning (retention/recall, concept learning, problem solving, attitudes, or motor skills) that your message will facilitate. **The first time through the procedure it is best to work with only one type of learning and one principle from each design aid.** After one is familiar with the process, it becomes easier to work with more than one principle, parameter, or type of learning. The design aid for types of learning is given in Table 2.

The principles represent the key questions relevant to each learning outcome. A designer could consult more complete compendiums of guidelines and principles specific to these types of learning.

Table 1. Example of a Completed Message Design Worksheet

Variable	**Principle**
Purpose/Idea	Second-grade students will value wearing a helmet when riding a bike. A videotaped presentation comparing the consequences of accidents with and without a helmet will be produced and used as part of an assembly.
Type of Learning	**Attitude Change:** Use sources that the learner can identify with and will consider credible. Members of the local Youth Cycle League will be asked to narrate the videotape and present it at the assembly.
Parameters of Message	**Age and Maturity:** Students at this age can frighten easily. It is important to emphasize serious consequences without raising anxiety to a level of defensiveness. Do this by offering helmet as a way to avoid consequences and procedures as a way to avoid accidents. **Channel:** This will be a group presentation. The average student usually learns best from an effective combination of audio and visual. Since this is attitudinal learning, it is not necessary to have physical practice. **Media:** Video sequences using narration. **Content:** Use an analogy of Humpty Dumpty situation or egg falling if not packaged. Show symbols of where law made and who enforces law. Include fashionable as well as out-of-date bikes and helmets. Talk about peer pressure.
Learning Paradigm	**Cognitive Science:** Script for assembly should include mental rehearsal of visual image of wearing helmet when riding. Guided fantasy or imagine putting on your helmet. What kind of helmet is it, etc. Include some non-examples in video and ask audience is he/she ready. Why not? Who's not dressed properly for riding?

Table 1. (continued)

Principles of Motivation	**Build Confidence:** In the videotape and the script for assembly give them a challenge that they can meet. Talk about what to look for when buying a helmet, how to get one if parents can't afford one now, and what to do until have helmet.
Principles of Perception	**Plan for Preattentive Perception Processing:** Start videotape presentation by explaining the safe bicycle riding depends on things that must work together including the rider and how he/she is dressed (with helmet), the bike and its safety equipment, and the rider's attitude and knowledge.
Design Principles	**Visual Design:** Focus attention through color, e.g. wild helmet, and use color in clothing to create character.
Description of Design: A videotape presentation for a scripted assembly will be narrated by a member of the Youth Cycle Club. The assembly will be hosted by a member of this club. The videotape will begin by explaining that safe riding depends on things that must work together including the rider's attitude, knowledge, attire, the bike's equipment, and the parent's rules. Color will be used to highlight, enliven, and make scenes realistic. Analogies of Humpty Dumpty and eggs packaged and unpackaged will be given. Pictures of the state capitol and police will be included. Fashionable and old bikes and helmets will be included. The topic of peer pressure will be discussed. Another topic will be how to tell parents about buying a helmet and what to do if parents don't have the money now. While the videotape is showing, students will be asked to yell out if characters are improperly attired. The tape will end by offering the helmet as a way to avoid the consequences of accidents. After the tape, the host or hostess (opposite sex from narrator) should bring students up and put helmets on some in line up and ask students to yell out when standing behind one who is guilty of not obeying the law. Then, the students should be lead in mentally rehearsing imagining putting on helmet and going on a guided fantasy ride.	

The second design aid summarizes parameters that may influence the design. This aid is given in Table 3. This aid cues consideration of learner characteristics, and channel, media, and content requirements.

The Learner Characteristics column suggests some factors that can affect other parameters. For example, learning style can indicate channel requirements (Smith & Ragan, 1993), or ability and attitude can indicate content parameters.

The Channel Recommendations column cues the designer to identify the means of sensory input. This step is important because it limits what media can be used and how media are used. A decision to use the visual channel only means that if a continuous visual presentation is used, such as video, it will be used without a soundtrack, which is an acceptable though seldom used way to design video sequences.

The Media Recommendations column prompts reaffirmation of media design decisions. This decision should be reconsidered in light of learner, channel, and content requirements. Integrated technologies includes the option of using people, for example, to deliver a speech. There seemed to be no place for people in this procedure. Yet, people are demonstrably the best way to communicate. Because people usually employ several channels and media when they deliver a message, this option has been placed with integrated technologies.

The Content Recommendations column reminds you that messages are based on symbolic language in both visual and verbal form. Therefore, important decisions must be made about what signs and symbols to use and what examples and topics will serve as vehicles. It is usually best to incorporate at least fifty percent familiar content as well as some novelty for motivation and challenge. The more anxious the learner, or the lower in ability the learner, the more important it is to use familiar imagery and language. Analogies and metaphors can be used to convey meaning.

Sometimes there are reasons why a designer wants instruction to be consistent with a learning paradigm. On the other hand, the designer may feel that in practice, the best strategy should be used regardless of paradigm consistency. In practice, some of the strategies, such as chunking and case study, are used historically by more than one paradigm. In many cases, followers of one paradigm do not agree with the narrowness of their philosophy as described by followers of another paradigm. Nevertheless, whether one paradigm is to be used consistently or elements of several paradigms combined rationally, it is reasonable to consider how a paradigm applies to the design you are planning. This design aid can reveal inconsistencies that should be eliminated. Table 4. is the Design Aid on Learning Paradigms.

Table 2. Design Aid for Types of Learning

Type of Learning	Principle	Example
Recall/Retention	Make associations meaningful	Use meaning as a basis for organization or grouping
	Repeated exposure to stimuli enhances retention	Use varied repetition
	Provide memory cues	Use imagery and mnemonics
Concept Learning	Carefully select examples	Use a wide variety
	Sequence rationally	Use simple to complex or superordinate
	Confirm concept learning	Have students identify or use concepts
Problem Solving	Facilitate acquisition of information	Emphasize through adjunct questions and highlighting techniques
	Provide guidance in structuring the problem	Demonstrate translating the problem into sentences or drawings
	Facilitate learning how to separate relevant and irrelevant information	Provide practice in selecting information from cues and directions
Attitude Change	Influence persuasiveness through choice of sources	Use sources that the learner can identify with and with enough information, experience, and intelligence to be considered credible
	Establish belief congruence	Argue in favor of a position the learner holds so that effectiveness is increased when presenting an argument in another area
	Provide balanced arguments that relate to the learner's needs	Create and manage dissonance; show how needs can be satisfied by adoption; recognize current attitudes and move in small steps towards the desired attitude; state the conclusion explicitly

Motor Skills	Cue mental practice	Cue steps in procedure
	Match presentation format to type of task	Use observation of model performance for simple tasks incorporating known skills
	Sequence appropriately for task characteristics	Use the whole-task approach for integrated and coordinated activities

Because motivation is basic to all other types of learning, every instructional message should incorporate principles of motivation. These design aids summarize the most important questions to consider. They are meant to be used with more extensive references in the literature on principles of motivation and on tactics for implementing these principles. For example, McAleese and Gunn (1994) list tactics for developing confidence (expectancy) as providing tests of performance, feedback, praise, advisement, and knowledge of results. Table 5 is the aid for motivation.

Table 3. Design Aid for Parameters of Message

Learner Characteristics	Channel Recommendations	Media Recommendations	Content Recommendations
Demographic, e.g. age, maturity, socio-economic background, geographic region, etc. Learning style, e.g. visual/auditory, sensory/intuitive, inductive/deductive active/reflective, sequential/global Ability and attitude e.g. high or low, anxious, enthusiastic	Audio Visual Audiovisual Kinesthetic Tactile Olfactory	Print technologies, e.g. frame, page Audiovisual technologies, e.g. shot, sequence Computer-based technologies, e.g. graphic, screen, sequence Integrated technologies, e.g. sequence, people	Sources of imagery e.g. cultural, professional Signs Symbols Examples Topics

Table 4. Design Aid for Paradigms

	Behaviorism	Cognitive Science	Constructivism
Paradigm Assumptions	performance oriented	domain oriented	problem context oriented
	know reality	construct schemata	construct reality
	designer perspective	designer and learner perspective	multiple perspectives
	mathemagenic strategies	mathemagenic strategies	generative strategies
	acquire knowledge		socially constructed meaning
Micro Strategies	contiguity reinforcement cuing feedback	chunking frames mapping advance organizer rehearsal mnemonics outlining metaphor/analogy	argument discussion debate reflection exploration interpretation construction
	minimize errors	visuals	use misconception
Symbols	direct attention	cue memory	tools for constructing reality
	external representation of reality	external and internal representation of reality	internal representation of reality

If learners do not attend the message, then communication and learning will not occur. Like motivation, perception is basic to all types of learning. Use the Design Aid on Perception Principles to ensure that the audience receives what is intended. It is assumed that the designer could at this point consult more complete compendiums of principles specific to types of learning, such as perception. Table 6 is the aid for perception.

There are instructional and aesthetic principles of design that come from media areas such as graphic design, visual communication, information design, screen design, and text design. These principles can be used to solve problems that are not unique to a type of learning, such as how to use space and how to organize symbols. Only a few of the many sources are suggested on the design aid. Use the principles offered to critically evaluate the design for the message; then, revise the design as suggested by the principles. Start by identifying a column (screen, text, information, or visual design) that relates to the message you are developing. Table 7 presents the aid for general design principles.

The last step in the procedure is to summarize a design plan based on the principles identified on the Message Design Worksheet. The form for this worksheet is presented in Table 1 which was presented earlier in this article. After summarizing the principles and parameters selected, a paragraph is written describing the creative approach to design and the theory exemplified by the design.

Table 5. Design Aid for Principles of Motivation

Type of Learning	Principle	Example
Motivation	Stimulate learner's attention and curiosity	Use variation in organization and presentation; provoke mental conflict
	Create a clear relationship between objectives and learner goals	Use analogies, metaphors, and personal language to build a relationship between content and objectives and learners' need and desires
	Build confidence to produce appropriate expectancy for success	Design appropriate challenge level
	Gain and maintain learner's attention	Make the presentation appealing by using print, writing style, graphics, formatting and images

Table 6. Design Aid for Principles of Perception

Type of Learning	Principle	Example
Perception	Plan for preattentive perceptual processing	Organize information using clear boundaries, clear figure-ground distinctions and clear units or parts
	Select and organize information to assist in attentive perceptual processing	Sequence information appropriately (top-bottom, left-right for English readers)
	Plan for learner interpretation	Consider learner characteristics, such as cognitive abilities, e.g. skills
	Structure visual perception	Provide good figures which are complete, balanced, and perceived as integrated rather then separate elements; group by proximity, similarity, common movement

This design plan should be reviewed by colleagues and representative learners and adjusted as recommended. After completing this theory-based procedure, the next phase, developing or producing the message starts. Changes in the message design concept can occur at this next stage also.

Discussion

Performance support systems take many forms at different levels of sophistication including calculators, word processors, workstations and just-in-time training on demand. This conceptual framework and procedure was conceived as a basis for interactive on-the-job training technology that would support message design activities. The database necessary for message design is so extensive that an "if-then" performance support system would be the ideal. This electronic performance support system could have as one of its components a decision making model based on this theory-based procedure.

This performance support system could also include an expert system to present an ideal approach to decision making, text retrieval to make references conveniently available and searchable, a data base to provide access to principles and guidelines, a browser to extend access to sources of information, and a neural network system to connect key words in the knowledge domain. Obviously, this proposed theory does not provide the interface or elements to develop such a system. Nevertheless, it is a start towards conceptualizing a performance support system that could accept input and adapt, provide multiple modes of access to information, and offer both practice activities and activities which require organizing knowledge. Task support worksheets could be supplemented by cue cards, wizards, coaching, explanations, checklists, tips, decision trees, decision making models, and process maps. The user could study through computer-based instructional sequences, look up information through on-line reference systems in hypertext, and ask advise of an intelligent expert system. Roles for experts and novices could be programed including roles for designers, writers, producers, artists, programers, and managers.

What form will the adaptation of technology for message design functions take? Will expert systems lead designers through the process or replace the designer? In the future will message design be done by machines or a man-machine system? Properly designed systems could allow non-experts to produce results similar to an expert. This would be done by the expert system querying the user to gain data about the situation. This data would then be processed by the system following built-in rules.

The process of message design becomes far less daunting when a database holds all the worksheets and checklists to be used. Once part of that database, the items that apply to the current design can be selected and created as working documents through screens committing the result to paper. Performing any job well calls for the consistent application of a set of rules or procedures. We all omit a step from time to time, but the computer never skips a step. Once properly programed the computer is capable of replicating results time after time. A debatable issue, however, is whether such a computerized support system would eliminate the creativity that distinguishes many superior messages.

One advantage of such systems could be the ability to manage the minutia of many design projects. Many designers are imaginative but uninterested in details. Turning the details of a project over to an electronic assistant frees the designer to be creative without losing control of the details. The computer could ensure full coverage of all the necessary steps in the process of message design presented by this conceptual structure.

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Title:

Computer Confidence: Factors Associated with Retention in the Community College

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Abstract

Pre-enrollment factors, particularly those related to computer confidence in using computer applications, were investigated in relation to persistence in the community college. Data on sex, ethnicity, reading level, high school grade point average (GPA), goal for attending college, and self-reported ability to use five computer application programs: word processing, database, spreadsheets, graphics, and on-line communications programs were gathered from 543 traditional, entering students and analyzed in relation to the students' persistence at the beginning of the subsequent semester. Univariate and multivariate statistical analyses were employed. Results of the logistic regression indicate that ethnicity, goal for attending college, confidence in using spreadsheets for college work, and the interaction between high school GPA and total number of computer skills that the student is confident using for college work are related to persistence in college. While future studies are needed to determine direct causal effects, community college administrators may wish to consider designing pilot programs in computer skills training for the at risk entering student.

Confidence in Types of Computer Use: Factors Associated with Retention in the Community College

Thirty-nine percent of the students pursuing higher education in the nation are enrolled in two year colleges (U. S. Department of Education, 1994). Although enrollment levels for the two year college population are projected to increase, a critical concern among administrators at these institutions is student retention. National survey data on the attrition of two-year college students from 1972 through 1990 show that, based on full-time, or a combination of full- and part-time, enrollment statistics, 40% to 44% of entering students do not persist to the second year (Tinto, 1993). Although some of these academic leavers may not consider themselves "dropouts" but rather "stopouts" who plan to return to college at some point in time (Bonham and Luckie, 1993; Conklin, 1993), their behaviors can be costly to their institutions, particularly as institutional resources become more limited. Colleges can plan resource allocations more effectively with consistent patterns of enrollment; students can also plan their futures more effectively when following a consistent attendance pattern.

At the same time, the nature of the K-12 experience for recent high school graduates has been changing as their potential for being exposed to newer technologies has increased. Data on 78% of 16,100 public school districts and intermediate units in the United States reflect a change from a ratio of 125 students per computer since the 1983-1984 school year to a ratio of 14 students per computer in 1993-1994, along with increased use of modems, local area networks and peripherals (Quality Education Data, 1994b). Projected spending for computer hardware in 1994 was estimated at $10,202,527,565 (Quality Education Data, 1994a).

The question arises of whether this increase in computing resources in the schools shows indications of contributing to success in college. More specifically, Q_1: Do traditional, entering community college students who indicate confidence in their ability to use one or more computer application program(s), or in their ability to use a specific type of computer application program (word processing, graphics, database, spreadsheets, on-line communications) to carry out college assignments demonstrate greater persistence in college after one semester than those who do not indicate such ability? Additionally, Q_2: Are the variables of gender, reading level, high school grade point average (GPA), ethnicity, and goals factors in this relationship?

Background

Student pre-enrollment factors, such as, gender, ethnicity, high school GPA, college aspirations; student college factors, such as, college GPA, academic and social integration into college, full- and part-time enrollment status; and institutional characteristics, such as, contact with faculty, access to resources, and availability of financial aid, have all been identified as playing a complex role in student retention (Gaither, 1992; Pascarella & Terenzini, 1991; Tinto, 1994). The complex role that confidence plays toward applying computer skills to academic work has also emerged in regard to factors, such as, age and motivation (Klein, Knupfer, & Crooks, 1993), gender, computer experience, and age (Loyd & Gressard, 1984), computer literacy levels (Hignite & Echternacht, 1992; Mahmood & Medewitz, 1989), and prior knowledge of, use of, and access to computers (Malaney, & Thurman, 1989). Despite extensive studies on college retention and on computer literacy, little research has been designed to explore relationships between the two.

Broadly defined, computer literacy includes student self-efficacy toward computer use as well as knowledge about computers and ability in computer usage (Simonson, Maurer, Montag-Torardi & Whitaker, 1987). In their meta-analysis of twenty years of college retention research, Pascarella and Terenzini (1991) state that "...the impact of college is largely determined by the individual's quality of effort and level of involvement in both academic and nonacademic activities". Might one, therefore, ask if levels of computer literacy could be related to some degree to the "quality of effort" that a student expends in college?

While concerns have also arisen over providing students with up-to-date computers and equitable access to computers, more importantly, research is needed related to computer use and learning (Apple, 1991; Becker, 1991; Billings, 1986; Muffoletto & Knupfer, 1993). Given the direct high cost of obtaining and maintaining computers and the indirect cost of training teachers, as well as the impact of computers on curriculum (Billings, 1986), there is a continuing need for research that examines the relation of computers to various aspects of learning.

The purpose of this study was to investigate a broad learning outcome, persistence in college, in relation to entering community college students' attitudes toward computers . Focus was placed on the relationship of confidence in the computer use of commonly used computer application programs to persistence in college in an attempt to gather preliminary data on the pre-enrollment characteristic of computer confidence in relation to these specific computer applications.

Method

The study was designed as a preliminary investigation into the relationship between persistence in community college and computer ability.

The participants were traditional, first year entering students who participated in the regular Orientation, Test, Advising, and Registration sessions (OTAR) conducted throughout the summer of 1993 at one of the largest community colleges in the University of Hawaii System. Recent high school graduates were selected because of the likelihood that they would have had experience using computers and would have formed opinions about their ability to use computer applications for carrying out college assignments.

As part of the OTAR process, the students complete a questionnaire designed to gather personal background and attitudinal data. For this study survey items, constructed by the authors, were added to gather data on the confidence students had in using specific computer application programs to carry out college work. This specialized strand of the overall analysis of the assessment process, focused on determining if such computer usage, specifically, word processing, computer graphics, spreadsheets, databases, and ability to access information electronically on-line could be factors in subsequent retention in college. The students' responses concerning confidence using computer applications were also calculated to obtain a total score, hereafter referred to as computer score. That score had the potential of ranging from zero to five.

On the computer survey, students were presented with a forced choice option of "yes", "no", and "uncertain" as it was unrealistic to ask them to indicate the degree to which they were confident in using these application programs to carry out college assignments. Either they would use the application to carry out a college assignment or they would not. The uncertain category was included to discourage some students from skipping a question. This study was designed to collapse the uncertain responses into the "no" response section during the data analysis phase of the study. Pilot testing of the instrument carried out prior to the initiation of the regular test sessions, employing a test-retest approach and interviewing techniques resulted in obtaining a reliability coefficient of .98, indicating high reliability for the instrument.

Six hundred fifteen students responded to the computer survey and to the request for information on pre-enrollment characteristics of gender, ethnicity, goal for attending college, entry level academic ability reflected through high school GPA, and reading score on the Nelson Denny reading test.

At the start of the second semester these students were tracked to check for re-enrollment in the college. Using student identification numbers, students were separated into groups delineated as persisters and as non-persisters. From the initial 615 participants, a total of 543 students consisting of those who had persisted and those who had left the college, were identified as having complete data sets n = 418 and n = 125 respectively. No attempt was made in this study to distinguish between "dropouts" and "stopouts".

Data Analysis

Data obtained from the participants were coded and entered into a computer database for analysis using SPSS for UNIX. Univariate comparisons were employed to test for differences between the two sets of students, persisters and non-persisters, in relation to the selected pre-enrollments factors. The chi-square statistic was used to test for the significance of the relationship between persistence in college and these factors.

Cells where small numbers were reported were collapsed, resulting in the ethnic categories of "Blacks" and "Hispanics" being added to the "Other" ethnic category. For the same reason, during the multivariate analysis process, computer scores of three through five were collapsed into a new category entitled, "three or more".

Treating the computer score and high school GPA as continuous variables, the possible relationship of confidence in ability to use one or more computer applications in combination with high school GPA levels to persistence in college was tested through a one-way analysis of variance.

To investigate the complex relationship of the factors together in relation to the dichotomous criterion variables of persistence and non-persistence in college, logistic regression was employed using a forward stepwise approach that selects predictors in order of importance. The forward stepwise method was chosen because of its applicability to college retention research studies designed to measure the dichotomous dependent variables of persistence and non-persistence in retention (Dey & Astin, 1993) and because of its power in selecting variables to remain in the final model (Retherford & Choe, 1993). The significance of each variable was tested with the Wald statistic. The probability for entering a variable into the model was set for $p \leq .05$ and the probability for removing it set at < 0.1.

Results

The results of the chi-square analyses for the pre-entry level characteristics of gender, ethnicity, entry level academic ability, reading ability, and goal for attending college indicate that gender, high school GPA, and reading level as measured by the Nelson Denny reading test, are not significantly related to retention. Ethnicity and goal for attending college were shown to be significantly related to retention in college, c^2 (4, N = 543) = 14.58, $p < .01$ and c^2 (, N = 543) = 11.46 $p < .01$ respectively. Asians were identified as the ethnic group that persisted at a greater rate than anticipated. Filipinos persisted slightly above the anticipated rate. Persistence rates were less than anticipated for all other ethnic groups.

Those students whose goal was transferring to a four year college and those students who indicated their goal was different from the standard options for attending community college persisted at higher rates. Interpretations about the significance of the latter group should be made cautiously, however, because of the small number of respondents in this category who persisted (n = 18).

Being a confident user of computer applications or not, was not significantly related to persistence in college. Those who persisted were less likely to express confidence for using word processing, graphics, databases, and on-line communications. Those students who were confident about their ability to use spreadsheet applications were the only type of specific computer application users who showed some indication of being more likely to persist than anticipated.

An examination the results presented in the crosstabulation tables in relation to computer score, showed no clear pattern of use emerging in regard to the number of skills students indicated they were confident in applying. The

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analysis of the interaction of the two variables: high school GPA and computer score indicated a significant effect , $p = .01$.

Table 1 lists the results of the forward stepwise logistic regression in which the important variables were examined together, presenting variables that remained in the equation along with their coefficient, standard error and indication of significance levels. The standards set for the equation were: for gender, being male; for ethnicity, being Asian; for high school GPA, having an average GPA; for reading, reading at or above the standard; for goal, planning to transfer to a four year college; and for each individual computer application, indicating being a confident user. For the computer score the standard was set at zero. The same standards were retained for the interaction variable of high school GPA and computer score.

The results shown in the display of the logistic regression model indicate that ethnicity, goal for attending college, confidence in using spreadsheet computer applications, and the interaction between high school GPA and confidence in total computer skills are significantly related to persistence in college.

Of particular note is that the majority of the significant variables indicate a negative effect on persistence. For example, the results suggest that those students who identify their ethnicity as being Hawaiian or Pacific Islander, White or Other, are significantly less likely to persist in college than the ethnic group used as the standard, the Asians. This negative effect is true for those students whose goal for college is personal enrichment and obtaining a two year degree. They are less likely to remain in college than their comparison group, those whose goal is to transfer to a four year school

The computer related variables that reflect significance are positively related to retention. Students who express confidence toward using spreadsheet applications for college work are significantly more apt to persist than those who do not indicate such confidence. In comparison to students with average high school GPA's who have indicated confidence in using no computer applications, students with low high school GPA's and three or more computer skills and those with high GPA's and two computer skills are significantly more likely to remain in college. As both these groups have small numbers of students, with the latter group containing less than fifteen students, the results of this interaction should be interpreted cautiously.

The factors of gender, high school GPA alone, reading level, and confidence in the separate skills of using word processing, databases, graphics, on-line communications and computer score alone did not contribute to the model.

The model created by the results of the logistic regression correctly classified 76.8% of the cases in terms of persistence in college; 26.8% more than would be accounted for by chance. Its limitations arise in its ability to predict persisters more accurately than it predicts non-persisters.

Discussion

The results of this study indicate that certain pre-entry student variables do relate to persistence in college with the categories of organismic factors, goal for attending college, and confidence in employing computer applications to college work each contributing to the resultant model. The investigation answered the research question, Q_1, with the finding that, for students in this study, being confident in applying a specific computer application, spreadsheets, is indicated as being the only computer application that appears related to persistence in college in conjunction with the other variables selected in the model. Being confident in using a total number of computer applications appears to only be related to persistence for students with either low or high GPA's. Closer scrutiny, however is warranted because of the small number of cases that contributed to the effect.

While at first it may appear surprising that having confidence in using spreadsheets was the one specific computer application that contributed to the equation, it may be a result of its possible relationship to mathematical ability, an aspect for which spreadsheet applications are predominantly used, and an aspect for which this study was not designed to investigate. Future studies may show that the spreadsheet factor is an effect of mathematical ability.

Research question Q_2 was addressed with the finding that ethnicity, goal for attending college and high school GPA in interaction with computer score appears to influence persistence in college for the students in this study.

The confidence in spreadsheet use factor was selected for inclusion in the equation during the multivariate analysis of the data, although it was not a significant factor when considered by itself. The lack of contribution that the other specific computer applications made to the model is not surprising, given the complexity of determining the relationship between attitudes toward computers and computer literacy. Hignite and Echternacht (1992) have documented this condition in studies with college populations. Mixed results may be found regarding the relationship between students' ability to use computers and planned future use. Larson and Smith (1993) found that entering college students who were computer users were less likely to have positive attitudes toward using computers. For the students in Malaney's and Thurman's (1989) college-based study, however, computer use before entering college, when combined with access to computers and anticipated future computer use, showed indication of serving to identify college users.

Although both the Larson and Smith (1993) sample and the participants in this study both gave indication of being able to use word processing, spreadsheets and graphics applications, more than half of the former indicated capability with these three applications; for the students in this study such confidence in using applications were indicated only for word processing. The lower confidence levels evidenced by these students may reflect the more demanding wording of the items in the survey where respondents were asked to state their confidence in using the various computer applications at the level of "carrying out college assignments". Computer usage in the Larson and Smith survey simply inquired about "familiarity" with the applications.

The omission of the confidence in word processing factor from the final logistic regression equation appears to be related to findings by Oliver and Kerr (1993) and Power, Fowles, Farnum, and Ramsey (1992) whose studies of actual word processing use by college students indicate that its use does not contribute to improved grades and scores. In regard to college students' writing, Oliver and Kerr found that the level of revisions, rather than the use of word processing contributed to improved grades on college students' essays. Powers et al. found that handwritten versus word processed work resulted in higher scores for the handwritten submissions.

As this study sought only to investigate the effect of pre-enrollment factors, the small contribution that this resulting model for persistence in college makes in identifying non-persisters may be explained by the work of Gates & Creamer (1984), who found in their review of a sampling of community college student records from a national database, that pre-enrollment variables account for only 4.3% of the variation in retention when such variables are the only type of variables used in the analysis. This study was not designed to gather data on student college or institutional factors that might contribute to persistence in college. Future studies could be designed to investigate the effect that the addition of such data would have on the resulting model.

Summary and Conclusions

This study sought to answer questions concerning the percentage of entering community college students who are computer confident and whether this confidence has any immediate impact on retention. If the cutting edge campus of the future is to be on the information superhighway, how important is it for students to arrive at the campus computer confident? Although limited by being based on the results of participants from one community college whose student body has a higher proportion of Asian, Filipino, and Hawaiian or Pacific Islanders than other community colleges; it does provide preliminary data and a framework in which other researchers may attempt to answer these and similar questions as they begin to address the broad questions posed by Bork (1993) with regard to the need for determining effective uses for computers. While future studies are needed to determine direct causal effects, the results of this study raise questions about the type and time frame for providing technological support to entering community college students. Community college administrators may want to consider developing pilot computer skills training sessions to be offered prior to college entry for the traditional, entering high risk students to determine the possible contribution that such training may have on subsequent student persistence in college.

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Table 1
Logistic Regression on the Effect of Selected Pre-Enrollment Characteristics on Persistence in the Community

Independent Variables	S.E. Coefficient	Logit
Organismic Variables		
Ethnicity		
Hawaiian/Pacific Islander	.3592	-1.2071***
White	.3894	- .9655**
Filipino	.3631	- .3652
Other, Black, Hispanic, American Indian	.3675	-1.0334**
Academic Characteristics and Goals		
Goal for attending college		
Personal enrichment	.8008	-1.6382*
Vocational/Technical certificate	.5314	- .7373
Two year degree	.3136	- .8513**
Other	.6491	.3660
Confidence in Computer Skills		
Spreadsheet	.3110	.8767*
Interactions with Confidence in Computer Skills		
GPA by confidence in total computer skills		
Low GPA by one computer skill	.7123	.8060
Low GPA by two computer skills	.8260	- .4212
Low GPA by three or more computer skills	.8837	3.2919***
High GPA by one computer skill	.6882	.5669
High GPA by two computer skills	.8487	1.6734*
High GPA by three or more computer skills	.6538	.8493
Intercept	.2470	.6697**

Note. Reference categories for the categorical variables in order of appearance above are Asian, transfer to a four year college, average GPA, and confidence in spreadsheet skills. For the interaction terms the reference is average GPA and confidence in zero computer skills. Variables that were not selected during the forward stepwise variable selection are gender, high school GPA, reading level, confidence in: word processing, database, graphics, on-line communications skills, and confidence in total number of computer skills.
* p < .05; **p < .01, ***p < 001

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Title:

Dimensions of Interest and Boredom in Instructional Situations

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Abstract

Keller (1983) has described motivation as "the heart" of our understanding of how to design effective instruction. Stimulating interest and reducing boredom are important goals for promoting learning achievement. This article explores boredom and interest in educational settings, examines their relationship to the characteristics of emotion, and describes the results of a research study intended to identify motivating factors and their sources in education.

Introduction

Much of the literature on instruction and learning focuses on cognitive outcomes that support one theory or another. Even though a learner's attitudes and motives can affect the results of even the most carefully planned and executed instructional intervention and continuing motivation has been called *the* major educational outcome of significance" (Sorensen & Maehr, 1976), educational researchers seldom examine the motivational antecedents and outcomes of learning (Engelhard and Monsaas, 1988). As a result, we know much more about the cognitive elements of instruction than about learners' feelings of involvement and enjoyment (Dodge, 1980).

Motivation is what Keller (1983) calls "the heart" of our understanding of how to design effective instruction. White (1959) wrote of an innate need to feel effective, while Deci (1975) described motivation as a need to feel competent and self-determining. Both of these needs were used to explain why we do things that have no subsequent extrinsic rewards, why we are interested in some activities for their own sake. Furthermore, emotional factors (combined with motivation, ability, and personality factors) have been found to contribute to learning and performance (Boyle, 1983). One possible explanation for the lack of substantive research is the multifaceted nature of learner motivation.

This article (1) examines the research on interest and boredom, (2) explores interest and boredom as emotional states, (3) describes some motivational elements and sources of boring and interesting learning situations through analysis of learners' descriptions, and (4) examines the attributions for those descriptions.

Interest and Boredom

Interest encompasses curiosity, engagement, and arousal (Berlyne, 1963). Sorensen & Maehr (1976) describe interest as the basis for the continuing motivation to learn. Keller (1983) links interest to the arousal and sustaining of a learner's curiosity. Malone (1981) asserts that intrinsically motivating environments depend on how well they continue to arouse and satisfy our curiosity.

Keller's ARCS Model of Motivational Design (e.g. 1987) designates four factors (Attention, Relevance, Confidence, Satisfaction) as critical preconditions to a learner's motivation to learn. Keller defines attention as a broad term encompassing interest and curiosity. The ARCS Model has as its foundation expectancy-value theory—that motivation is predicated on the importance (value) of the task and the perceived ability to achieve it (expectancy for success). There is evidence that the Attention and Relevance factors contribute to the valuing of a learning task while the Confidence and Satisfaction factors contribute to the learner's expectation for learning success (Small & Gluck, 1994). The ARCS Model is the only instructional design model to examine learner interest and prescribe a range of instructional strategies that promote it.

Duffy (1972) found links between reported interest and value. He found that not only did adolescents claim greater interest in what they found valuable, but they also asked more questions and learned and remembered more. Arnone & Small (1995) theorize that without learner attention and interest, there can be no relevance, confidence, and satisfaction potential. They reason that a lack of learner interest results in failure to pay attention to instruction and, therefore, none of the other motivations could emerge. They perceive learner interest, specifically curiosity, as a foundation of motivation.

Damad-Frye & Laird (1989) concede that as an emotion, boredom shares many of the same processes as other emotions (e.g. happiness, anger). Berlyne (1960) and others (e.g. Fiske & Maddi, 1961; Geiwitz, 1966) agree with Damad-Frye & Laird's contention that the basic element of boredom behavior is the "struggle to maintain attention"

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(p. 316) and define boredom as "a metacognitive judgement about one's attentional activity" (p. 320). When learners are bored, they pay less attention, resulting in lower retention and less ability to apply information.

Berlyne (1960) describes boredom as a state that occurs when external stimuli are excessively scarce or monotonous, or what Keller (1987) might describe as "a lack of perceptual arousal." Robinson (1975) found that monotony and repetition were perceived major causes of boredom. Bernstein (1975) provides one view of boredom as "a feeling, an affective response to an appropriate external situation" (p. 513). Fenichel (1951) claims that boredom arises "when we must not do what we want to do or must do what we do not want to do" (p. 359). Marsh (1983) found that students engage in certain behavioral patterns simply to mask their boredom and attempt to appear interested. Boredom may also be a result of information underload—too little information that is interesting or information overload—too much information that is not interesting (Klapp, 1973).

However, boredom, like interest, is a complex feeling state in which inattention may only be one dimension. Perkins & Hill (1985) found that although boredom was not significantly correlated with "meaningless stimulation," the term "meaning" may have been interpreted differently by different subjects; i.e., a stimulus might be "meaningful" if it is perceived as *relevant* to the perceiver's motive satisfaction or frustration. Dodge's (1981) "Boredom Analysis Flowchart" provides some links between boredom and instruction that is too complex, too difficult, and/or too detailed. The result may be lack of *confidence* and feelings of incompetence. Farmer & Sundberg (1986) found, among other things, a negative relationship between boredom and life *satisfaction*. All of these infer a relationship between interest (or attention) and the other ARCS components.
Both pleasantness and self-determinism may also be conditions of interest, while lack thereof may point to conditions of boredom (Kopp, 1982). Kopp's first step for designing boredom out of instruction is to analyze the potential for arousal, pleasantness, and self-determinism. He recommends instructional strategies such as novelty, surprise, incongruity, and uncertainty as anti-boredom strategies.

The Study of Emotion

For much of this century, psychologists tended to avoid the empirical study of emotion. There were three reasons for this avoidance: 1) behavioral scientists tended to view emotion as a unitary, global concept, which made operationalization difficult; 2) stimulus-response drive-reduction principles dominated psychology; and 3) there was no adequate theory dealing with separate and distinct emotions, each definable as a construct that could be studied by specified and repeatable operations. As a result, the realm of emotion remained a relatively unexplored territory (Izard, 1971).

When emotion was discussed within theories of motivation and behavior, it was often regarded as unidimensional. Hedonistic theories of motivation tended to view emotion along a single continuum of pleasantness-unpleasantness (e.g., McClelland, Atkinson, Clark, and Lowell, 1953). Activation theorists redefined emotion as arousal, varying along a sleep-tension dimension. One even advocated abandoning the term "emotion" altogether (Duffy, 1962).

One aspect of emotion that lent itself to scientific study was the area of facial expressions. Typical experiments involved the rating of paired photographs of an actor displaying a range of emotions. In those studies, two dimensions appeared: Pleasant-Unpleasant, and Sleep-Tension (Schlosberg, 1954; Gladstones, 1962). A third dimension sometimes appeared in such studies, but it was usually weak and difficult to interpret. Abelson and Sermat (1962) concluded that a two-dimensional model adequately accounted for differences in facial expression.

In contrast to studies of facial expression, research on verbal reports of emotion has often shown a three-dimensional structure. Izard (1972), for example, gave subjects the names of the eight fundamental emotions (fear, shyness, interest, distress, anger, guilt, joy, and surprise) in his typology and asked them to recall a situation in their lives in which each emotion was strongly experienced. For each situation, subjects also filled out a rating scale which asked them how active, deliberate, tense, impulsive, controlled, self-assured, extraverted, and pleasant they felt.

Analysis of the ratings showed that the Pleasantness, Tension, and Self-Assurance dimensions were the best combination to distinguish the eight emotional situations. Joy, for instance, was characterized as being high in

Pleasure and Self-Assurance, and low in Tension. Izard concluded that the three dimensions of Pleasure, Tension, and Self-Assurance represent the underlying structure of subjective experience of which emotion is one aspect.

In another attempt to uncover the dimensions of emotion, Bush (1973) asked subjects to rate pairs of emotional adjectives (e.g., sleepy, outraged, delighted) on a 10-point similarity scale. The ratings were analyzed by multidimensional scaling analysis. Three dimensions emerged: the first two were Pleasantness-Unpleasantness and Level of Activation. These are similar, if not identical to the Evaluation and Activity dimensions found in semantic differential research, (Osgood, Suci, & Tannenbaum, 1957), as well as to factors found in studies of facial expression.

Bush (1973) labeled the third factor found in his study "Aggression," though he noted that the scale was not easily interpreted. At one end were adjectives like "outraged" and "delighted," while at the other were "sympathetic," "needed" and "desperate." He concluded that this dimension was closely related to the Potency scale of the semantic differential and, more specifically, seemed to refer to interpersonal potency.

Additional support for a three-factor model of emotion comes from work by Mehrabian and Russell (1974) in the field of environmental psychology. Based on previous research, they theorized that the emotional response to an environment can be described along the dimensions of Pleasure, Arousal, and Dominance, in parallel to Evaluation, Activity, and Potency (Osgood, Suci, & Tannenbaum, 1957). They constructed an 18-item measure based on these factors and used it both as a measure of personality and as a state measure of emotional response. As they predicted, the measure was found to relate to measures of anxiety (high Arousal, low Pleasure and Dominance), sensitivity to rejection (low Dominance), and several other measures. A state emotional response scale (Mehrabian & Russell, 1974) was used to measure reactions to a number of environmental situations, and the three dimensions of emotion were significant predictors of various approach and avoidance behaviors.

A later study (Russell & Mehrabian, 1977) used the same scale to rate adjectives which depicted a full spectrum of emotions. A total of 151 terms were used, and each subject rated 10 to 20 of them. Again, the Pleasure, Arousal, and Dominance scales showed high reliability (.97, .89, and .87) and all three scales were necessary to distinguish among the emotional adjectives.

Interest and Emotion

With the exception of work by Csikszentmihalyi (e.g., 1975), there have been few attempts to examine in depth what interest and involvement *feel like* to an individual.

> Intrinsic motivation presents a fascinating case of the state of the art. Theories and data abound. Are we making major advances in understanding motivation? Let us suggest that they are minor. We continually overlook our major source of knowledge—a personal, non-objective source which is at the heart of every minitheory but not acknowledged. Our methodologies fall short because they lead us into more and more detailed specification of external conditions for producing behavioral effects and ignore the critical variable, namely, the way the person experiences (not perceives) the conditions that we so elaborately contrive. (DeCharms & Muir, 1978, p. 107)

This is not to say that emotion has been *totally* ignored by those doing research on learner interest. Several theoreticians have called upon emotions as explanatory variables in their writings. Berlyne (1960), for example, said that curiosity comes as a result of a desire to maintain an optimal level of arousal. Things that are puzzling or incongruous cause a rise above this optimal level, and the individual studies and processes the stimulus in order to reduce uncertainty and bring arousal back to a more comfortable tonus level.

Day (1982) extended Berlyne's work, describing a "zone of curiosity" as a state of activation (arousal) in which a person is interested and excited, as demonstrated by exploration and approaching behaviors. When not in this zone, the person is either in a "zone of relaxation" (boredom) or "zone of anxiety," (avoidance behaviors and disinterest).

Another line of research on interest has involved the development and use of interest inventories: scales to measure preferences among sets of school subjects or vocations. The interest inventory can be viewed as a technological extension of hedonistic theories of motivation. That is, they assume implicitly that we are pleasure-seeking creatures who arrange our activities to maximize pleasure (Travers, 1978).

The major work to date which studied the actual experience of interest and involvement has been conducted by Csikszentmihalyi (e.g. 1975; 1980). Csikszentmihalyi surveyed and interviewed chess players, rock climbers, surgeons and others to examine what made their activities self-rewarding. He discovered several qualities that seemed to characterize the occurrence of intrinsic motivation, a state of mind that he called "flow." Among these were a merging of action and awareness, the centering of attention, and the loss of self-consciousness. In emotional terms, the flow experience combined enjoyment, a feeling of mastery and control, and a level of arousal midway between boredom and anxiety.

Within this sample of inquiry in the area of interest, several different emotional variables have been cited as causes or correlates of interest. One might infer from this that interest is not a simple, pure emotion like happiness, for example, but a complex combination of feelings. If this is so, then perhaps the existing mini-theories of curiosity and intrinsic motivation are accurate but incomplete, like the fabled blind men's description of the elephant. The tendency to regard interest as one-dimensional has held back progress toward understanding it, and prevented the building of a cumulative body of research. We posit, then, that learner interest may indeed be a multidimensional construct.

A Model of Learner Interest

If interest is multidimensional, what are its dimensions? A logical analysis of the concept would suggest that the three factors underlying other emotions also make sense as dimensions of interest. The Pleasure-Displeasure dimension, for instance, is clearly relevant. To be interested is a pleasant feeling, to be bored is not.

The Arousal dimension seems applicable to interest as well. Any definition of interest would have to include notions of a heightened awareness and level of attention, both of which are associated with moderate to high levels of arousal. Drowsiness and lack of interest, on the other hand, are states of low arousal. As already noted, arousal also figures prominently in previous research. Perhaps the best articulated theory of curiosity, that of Berlyne (1960, 1963), is built around the concept of arousal. Furthermore, both Day and Berlyne theorize that only aroused persons learn and, when aroused, they learn better. In addition, the "flow" state studied by Csikszentmihalyi (1975) was characterized by a facilitative level of arousal.

Thus, an argument for Pleasure and Arousal as factors underlying learner interest is justified. But what about the third dimension, one that is related to the Potency (strong-weak) dimension of semantic differential research? This question might be rephrased for our purposes as: In an educational setting, what does it mean to feel stronger or weaker?

Learning adds to one's skills and abilities and thus enables one to deal more effectively with the world. In a sense, an increase in competence is an increase in power. To feel more competent is to feel stronger, while incompetence and weakness are inextricably linked. Thus it would seem that a dimension of Competence-Incompetence feelings is an appropriate translation of Potency within the context of learning.

The Competence Feeling dimension is tied to interest by some of the theoretical work already cited. Learners need to actively explore situations where they feel competent and self-determining (Deci, 1975; Keller, 1983; Lepper, 1985). Deci's (1975) cognitive evaluation theory proposes that activities which enhance a feeling of competence and self-determination are intrinsically motivating. Learners want to feel personally effective in managing their learning environment and seek out intrinsically motivating activities (Kinzie, 1990); i.e. activities done for their own sake, without the need for external compensation.

In an essay on interest and effort in education, Dewey (1913) made a distinction relevant to the Competence Feeling dimension. He said that there are two types of pleasure. One arises from contact with pleasurable stimuli such as bright colors and agreeable sounds. The second accompanies activity and is found wherever there is successful achievement and mastery occurring. These two types of pleasure are reflected in the present model as the Pleasure and Competence Feeling dimensions, respectively.

Dewey had few kind words for school activities which excite the senses but do not engage the learner in activity geared toward mastery. This same concern is echoed today when some argue that instruction, which produces high levels of Arousal and Pleasure but does not arouse Competence Feelings, can be said to be more entertaining than educational. High levels of Pleasure, Arousal, and Competence Feelings, on the other hand, would indicate genuinely engrossing instruction that promotes learning outcomes.

Some empirical evidence for the appropriateness of a Competence Feelings dimension comes from a study of what makes an educational television program interesting (MacLean et al, 1960). In an analysis of viewer ratings of several program segments, factors of Evaluation (good-bad) and Activity (fast-slow) emerged which are closely linked to the Pleasure and Arousal dimensions discussed above. In addition, a third factor appeared which had to do with how well the program was understood. The researchers named this factor Simplicity, but it is clear from the items which loaded on the factor that it could as easily have been interpreted as a dimension of Competence Feelings.

Thus far, we have described learner interest as having underlying dimensions of Pleasure, Arousal, and Competence Feelings. There is one more dimension yet to be described, one which also has to do with Potency.

Strength and weakness in an educational context can also be conceptualized in another way. One is strong when one controls the content and mode of presentation of what is being learned. Weakness is having no such control. This second type of Potency dimension is linked to learner interest by the widely held assumption that learner control enhances motivation. This feeling of being in charge of one's learning is closely akin to the Origin-Pawn theory of deCharms (1968, 1976). To use Deci's (1975) terminology, this dimension might be referred to as one's Self-Determination Feelings.

Kinzie (1990) states that "when actively exercised in a responsive environment, options for learner control can promote perceptions of personal control and further strengthen continuing motivation." (p. 8) She sees learner control as contributing to learner interest and engagement. Kinzie further asserts a direct relationship between competence and selfdetermination and links them to control, describing them as factors that influence the learner's interest in the instruction and contribute to the learner's continuing motivation.

Thus, a four-factor model of learner interest is proposed, consisting of the three-factor structure of emotion and a logical analysis of the concept of learner interest. These four factors related to the Evaluation, Activity, and Potency dimensions of semantic differential research (Osgood, Suci, & Tannenbaum, 1957) appear in Table 1.

Semantic Differential Dimensions	**Learner Interest/Emotional Factors**
Evaluation	Pleasure
Activity	Arousal
Potency	Competence/Dominance & Self-Determination

Table 1. Emotional Factors Related to the Semantic Differential Dimensions

Uses of the Model

A model of learner interest may be useful both as a conceptual tool and as a guide toward the solution of instructional problems. At the conceptual level, the model helps to bring diverse theories and approaches together within one framework. This provides a more holistic view of interest, affect and motivation and makes it easier to compare theories or to combine different theoretical perspectives.

This model also enables one to make finer distinctions than is possible with a single dimension ranging from boredom to high interest. The four factors can economically portray a wide range of affective/motivational responses to instruction. For example, one form of boredom might be represented by a combination of negative pleasure and low arousal. A closely related state would be drowsiness, which is mildly pleasant and low in arousal. The combination of high pleasure, moderate arousal and neutral competence and self-determination feelings might constitute a sort of passive fascination. Perhaps the optimum response for designers to strive for would be what Csikszentmihalyi (1975, 1990) calls "flow," a state of total involvement consisting of moderate arousal and high pleasure, competence, and self-determination feelings.

It should be pointed out that the emotions associated with interest and boredom are less powerfully felt than are other well researched emotions like fear. Affective reactions to instruction are subtle. Lipson (1979) calls them "aesthetic emotions" and notes the total lack of research on them.

In summary, research on motivation in learning situations has rarely looked at:

- student perceptions of what they find motivating.
- the various dimensions of interesting and boring instruction.
- the feelings and emotions learners experience in boring and interesting learning situations.
- the instructional causes of interest and boredom and their attributed sources.

The research questions in this study were:

1. What specific instructional factors contribute to learner boredom and interest?

2. To what underlying instructional source(s) do learners attribute those factors?

3. What are the dimensions of learning interest and boredom as they relate to emotion?

Methods

This research was conducted using 512 student subjects from two universities. Two methods of data collection were used:

1. *Descriptive responses.* Subjects were asked to reflect on past learning experiences in two ways:

    - Brainstorming sessions were conducted with 350 undergraduate and graduate students at a large northeastern university. Subjects were asked to voluntarily describe orally one boring and one interesting past learning experiences and the contributing factors. Responses ranged from single words (e.g. "dynamic," "disorganized") to phrases (e.g. "excited about subject matter," "content irrelevant"), to complete sentences (e.g. "The instructor used a variety of teaching methods." "There were no real-life applications.")

    - Written questionnaires were administered to 162 graduate students at a large western university. Subjects were asked to briefly describe one boring and one interesting learning experience and the critical factors contributing to each. Examples of each appear below.

Boring: "The subject of the lecture was "the relationship between ideas and other aspects of culture and social structure" in a class titled "Industrial Sociology." The classroom was fairly full, maybe 25-30 people. No-one seemed particularly interested. The whole lecture seemed to me to be a history of religion more than anything else and I could not understand its relevance to what we were to learn. He did not seem to care about the fact that no-one was interested in what he was saying. He never gave us a chance to ask questions, and he just talked on and on. He seemed to be totally wrapped up in himself and the fact that he knew so much about the subject. He did not take the particular audience into consideration."

Interesting: "The most interested I have been in any one classroom situation was in a graduate level statistics class on probability. It was a large class of about 50 students. The instructor did not use a text but supplemented his lectures with handouts and tasks to be completed each week. This particular class I recall not understanding well before class but the instructor was able to give examples and used a story about tea leaves so well that I knew I understood by the end of the 3 hours. I appreciated the teacher's style and ability to explain a difficult subject area in a clear and interesting way.

2. *Subjective evaluations*. Subjects who completed the open-ended, written questionnaire also completed two Likert-type scales.

    - Scale 1. This scale required subjects to rate their boring and interesting learning situations on a seven-point scale containing nine bipolar terms derived from the literature. These terms were *predictable-unpredictable, complex-simple, impersonal-personal, easy-impossible, colorless-colorful, changing-unchanging, ineffective-effective, familiar-unfamiliar, irrelevant to my needs-relevant to my needs.*

    - Scale 2. This scale required subjects to rate their emotions during each of the two learning situations they described on a seven-point scale containing 48 pairs of unrelated terms. The 67 terms reflected a wide range of emotional terms found in the literature that related to the emotional factors (i.e., *pleasure, arousal, competence, self determination*). The unrelated terms were randomly assigned to each scale item; as a result, 23 terms appeared more than once. Three terms appeared three times (*dull, excited, snobbish*) and one term (*cruel*) appeared four times. Some examples of paired terms appearing on this scale are *cruel-happy, excited-untroubled, dull-humiliated, in control-cared for, sad-frustrated.*

Results

Descriptive response data were used to answer both Research Question #1 (What specific instructional factors contribute to learner boredom and interest?) and Research Question #2 (To what underlying instructional source(s) do learners attribute those factors?).

Brainstorming responses were transcribed from overhead transparencies. Each response was reviewed and, when multiple ideas were represented, broken down into separate single ideas for analysis. For example, one subject volunteered the following complex response which was broken down into four separate ideas:

- His lecture consisted of telling us exactly what we had read the night before.
- He never translated the difficult textbook we had.
- He only made things foggier.
- He talked slowly and in a monotone.

All responses were analyzed by a panel of three motivation experts who were trained in the ARCS Model. Each expert categorized the responses in terms of Keller's ARCS Model motivation components [Attention (A), Relevance (R), Confidence (C), Satisfaction (S)] and attribution; i.e., to what/whom they attributed responsibility for the situation [Instructor (I), Learners (L), Materials (M), Environment (E)] Categorization continued until consensus was reached. In cases where no consensus could be reached, the items were eliminated from the analysis.

A total of 780 responses were analyzed (see Tables 2 and 3). There were slightly more interesting statements (407; 52%) than boring statements (373; 48%). The panel was unable to categorize 57 statements according to ARCS categories (e.g. "The instructor was handsome"). All statements were successfully categorized by attributed source.

	Instructor		Learner		Materials		Environment		TOTAL	
Attention	127	(66%)	35	(18%)	30	(16%)	1	(0%)	193	(51%
Relevance	40	(45%)	29	(32%)	20	(22%)	1	(1%)	90	(24%
Confidence	45	(63%)	22	(31%)	4	(06%)	0	(0%)	71	(19%
Satisfaction	13	(54%)	8	(33%)	3	(13%)	0	(0%)	24	(06%
Subtotal	225	(60%)	94	(24%)	57	(15%)	2	(1%)	378	
Unable to Categorize	11		2		16		0	(0%)	29	
TOTAL	**236**	**(58%)**	**96**	**(24%)**	**73**	**(18%)**	**2**	**(0%)**	**407**	

Table 2. Interesting Statements

	Instructor		Learner		Materials		Environment		TOTAL	
Attention	125	(58%)	11	(05%)	73	(34%)	7	(3%)	216	(63%
Relevance	22	(30%)	5	(07%)	45	(63%)	0	(0%)	72	(21%
Confidence	25	(63%)	2	(05%)	11	(27%)	2	(5%)	40	(11%
Satisfaction	12	(70%)	2	(12%)	3	(18%)	0	(0%)	17	(05%
Subtotal	184	(53%)	20	(06%)	132	(38%)	9	(3%)	345	
Unable to Categorize	12		1		10		5		28	
TOTAL	**196**	**(52%)**	**21**	**(06%)**	**142**	**(38%)**	**14**	**(4%)**	**373**	

Table 3. Boring Statements

Results of this analysis related to Research Question #1 (What specific instructional factors contribute to learner boredom and interest?) indicated:

- Attention statements were the most common for both boring (63%) and interesting (51%) situations. As such, Attention may be the most influential for generating interest. Furthermore, attention and relevance accounted for the vast majority of boring (84%) and interesting (75%) situations. This may indicate that the *value* of the learning task is the predominant influence on both positive and negative motivations.

- In boring situations, instructional materials were perceived as most important for providing relevance (63%), while the instructor was most important for providing attention (58%), confidence (63%), and satisfaction (70%).

Results related to Research Question #2 (To what underlying instructional source(s) do learners attribute those factors?) indicated:

- The instructor was the overall source of more than half of the statements in both situations (boring: 52%; interesting: 58%); even higher for Attention alone (boring: 58%; interesting: 66%). However, although subjects attribute the majority of the responsibility for their motivation to the instructor's performance, other factors also play a role.

- Subjects considered themselves (the learners) a more influential factor in interesting situations (24%) than in boring ones (6%). That is, it appears that subjects believed that when a learning event is interesting, it is more often due to something they have done; but when it is boring, they assume almost no responsibility.

- Instructional materials were a more important factor in boring situations (38%) than in interesting (18%) situations. Materials that are not perceived as valuable or contributing to learning success may not be useful as motivational techniques.

- Environmental conditions (e.g. a cold classroom, uncomfortable seats) have almost no influence (boring: 4%; interesting: 0%) on the motivational level of a learning event .

Additional data related to Research Question #1 were collected from 162 subjects at one university. Subjects used a seven-point scale of nine bipolar terms (derived from the literature) to characterize both their interesting and boring learning situations. Values were assigned so that each item on the scale ranged from "most" to "least." For example, a score of 7 on *predictable* was interpreted as "the most predictable" while a score of 1 meant it was considered "the *least* predictable."

For the purpose of this analysis, all data were combined and interest was used as a dependent variable. Multiple regression analyses were performed (see Table 4). Among the nine independent variables, *colorful, effective*, and *personal* emerged as the best antecedents of an interesting situation. *Predictable* appears to be a complicated influence. Although *predictable* had some negative influence, it was not strong. One interpretation might be that in one sense too much predictability might cause boredom but some predictability may be a positive influence on interest. For example, organized instruction that is predictable (e.g., structured, organized) may be positive while use of the same instructional methods (e.g., lecture, role playing) all the time might be considered a negative type of predictability. Other independent variables had no significant influence upon the situation's degree of interest or boredom.

Variable	Beta	T	Sig T	Reject Null?
Colorful	.454	10.461	.000	Yes
Effective	.411	10.125	.000	Yes
Personal	.123	3.347	.001	Yes
Predictable	-.049	-2.276	.024	Yes
Complex	.021	1.079	.281	No
Easy	-.020	-1.042	.298	No
Changing	.022	.708	.479	No
Familiar	-.012	-.663	.508	No
Relevant	.044	1.608	.109	No

Table 4. Results of Multiple Regression Analyses for Nine Independent Variables

A series of correlations analyses were conducted to identify the causal relationships between interest and each of the independent variables. The results appear in Table 5. Results indicate that *colorful* is the best antecedent of an interesting situation while *predictable* appears to be the best antecedent of a boring situation.

Variable	**Gamma**	**Pearson's R**	**Kendall's Tau-b**	**Kendall's Tau-c**
Colorful	.980	.913	.774	.961
Effective	.945	.902	.776	.963
Personal	.946	.835	.716	.915
Changing	-.887	.767	.651	.836
Relevant	.886	.729	.647	.824
Complex	-.372	.292	.248	.324
Easy	.165	.164	.109	.140
Familiar	-.135	-.107	-.089	-.117
Predictable	-.671	-.549	-.461	-.602

Table 5. Correlation Analyses for Interest and the Independent Variables

Additional results indicate:

- *Colorful, effective*, and *personal* have a significant positive influence upon the degree of interest. These three terms might be seen as correlates of the three dimensions of our interest model; i.e. colorful-arousal, effective-pleasure, personal-competence.

- *Changing* and *relevant*, although not statistically significant, show a positive influence upon the degree of interest, while *predictable* has a significant negative influence on the degree of interest. Students appear to prefer instruction that is novel, surprising, varied—major characteristics of Keller's (1987) Attention factor.

- *Complex, easy*, and *familiar* have no significant influence upon the degree of interest. However, mean scores for both boring and interesting situations were almost the same for *complex-simple* (boring: 3.0; interesting: 3.3) and *easy-impossible* (boring: 3.7; interesting: 3.0). One possible explanation is that when learners feel competent, complexity and difficulty (challenge) heighten interest; otherwise they contribute to boredom.

Research Question #3 (What are the dimensions of learning interest and boredom as they relate to emotion?) was explored through administration of a second scale to the same 162 subjects. This scale, based on similar scales developed by Russell (1978) (with reliabilities ranging from .70 to .95) consisted of a set of 48 items each containing two non-bipolar terms (e.g. dull-troubled, friendly-scornful). Items contained terms randomly selected from a list of 69 terms, which meant that some terms appeared more than once in this scale.

Subjects were asked to describe their feelings by placing a check-mark somewhere along a nine-point line between the two terms, as in the example below.

Cruel ___ : ___ : ___: ___ : ___ : ___ : ___ : ___ : ___ *Happy*

Each subject was asked to rates both their interesting situation and their boring situation using this set of terms.

Before these data were analyzed, a set of assumptions were made about the process subjects used to complete this task. It was assumed that the subject would first choose one of the two terms as more descriptive than the other of each of their situations. Then, based upon the descriptive strength of the term selected, the subject would select a position along the scale. For example, in the item *cruel-happy*, the subject might believe that he felt more *happy* than *cruel*, decide to what degree of *happy* he felt, and place a check-mark in one of the four spaces closest to the term *happy* as in the example below.

Cruel ___ : ___ : ___: ___ : ___ : ___ : ___ : _x_ : ___ *Happy*

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Furthermore since, generally speaking, the terms were not antonyms, we could not assume the score reflected the degree on two terms;,i.e., if the subject had placed a check-mark on the space closest to *happy* it might be interpreted that the subject was at the highest degree of *happy* but could not be interpreted that he also felt at the lowest degree of *cruel*. It was assumed that once the subject chose *happy*, he would only concentrate on how to quantify his *happy* degree and didn't care about his *cruel* degree. The check-mark located on one side of the scale or the other reflects 1) the strength of this term alone as a suitable descriptor and 2) the failure of the other term to be chosen, with no designation of failure strength.

Based on the above rationale, all 48 items were broken into two one-term measures and scored according to the four closest spaces to that term. The middle space was coded as 0 for both terms. Two examples appear below (F means failure to be chosen)

Cruel _1_ : _2_ : _3_: _4_ : _0_ : _F_ : _F_ : _F_ : _F_ *Happy*

Cruel _F_ : _F_ : _F_: _F_ : _0_ : _4_ : _3_ : _2_ : _1_ *Happy*

The ten highest- and lowest-scoring terms were determined for both the boring and the interesting situations. Repeated terms were removed from each list leaving six highest-scoring terms and ten lowest-scoring terms for the interesting situations and nine highest-scoring terms and eight lowest-scoring terms for boring situations. (The terms and their scores appear in Table 6). Four highest-scoring terms for interesting situations were among the lowest-scoring terms for boring ones while two highest-scoring terms for boring situations were among the lowest-scoring terms for interesting situations.

Interesting (highest-scoring)

Term	Score
interested	587
wide-awake	532
happy*	496
alert	481
friendly*	476
excited**	433

Boring (highest-scoring)

Term	Score
uninterested	479
unmotivated	417
frustrated	406
angry*	355
controlled	286
dull**	279
distressed*	264
adverse	261
nasty*	255

Interesting (lowest-scoring)

Term	Score
enraged	-149
vicious	-149
spiteful	-153
scornful	-154
cruel***	-156
adverse	-156
hateful	-158
tyrannical	-159
nasty*	-160
angry*	-162

Boring (lowest-scoring)

Term	Score
hopeful	-97
friendly*	-97
excited*	-98
affectionate*	-109
wide-awake	-113
interested	-126
sad*	-129
calm	-138

Table 6. Highest- and Lowest-scoring Terms for Interesting and Boring Situations
[appears twice; ** appears three times; *** appears four times]*

The results of this analysis indicate that subjects tended to use more extreme ranks to describe interesting (433-587) than boring (255-479) situations. Two possible explanations are: (1) the experimental situation was above average; i.e, the distance between subjects' interest feeling and their expectation of interest was shorter than the distance between their boredom feeling and their expectation of boredom and (2) subjects were more reluctant to rate negative terms highly than to rate positive terms highly.

Analyses (i.e., Pearson r correlation, Pearson r square) were conducted on each word term pair in order to yield a coefficient of nondetermination. A coefficient of nondetermination reflects that proportion of the variance which cannot be predicted by or determined by the other variable. Those word-pairs with a coefficient of nondetermination value equal to or greater than 0.90 were selected, yielding 34 orthogonal measure pairs. Similar terms were grouped together linguistically producing the boredom-interest model shown in Figure 1. This model is consistent with previous research on emotion. The terms along the horizontal axis reflect the Arousal dimension, while those along the vertical axis reflect the Pleasure dimension. The third axis reflects both factors (competence and self-determination) along the Potency dimension.

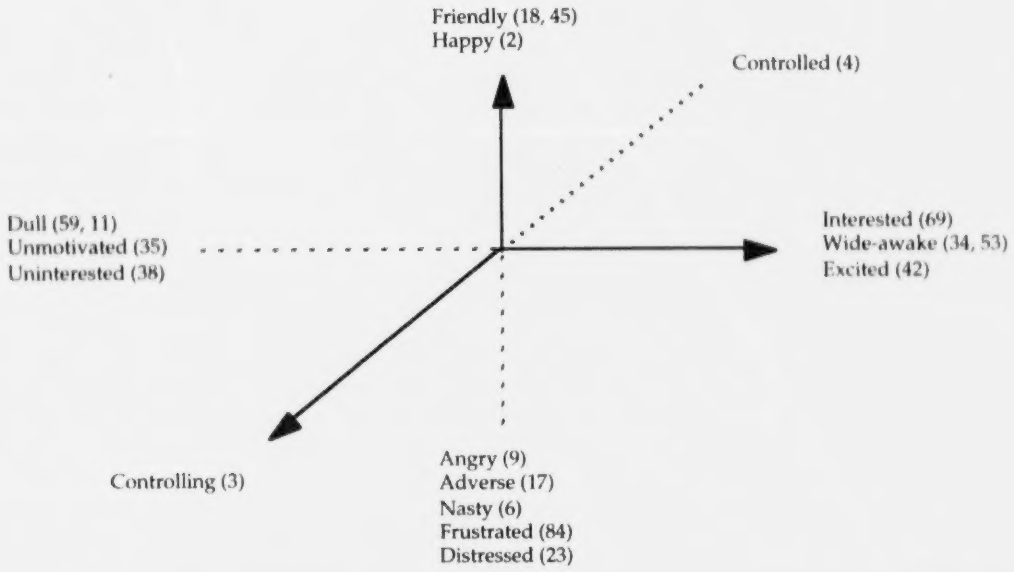

Figure 1. Boredom-Interest Model for Instructional Situations

Conclusions

This study explored the various emotions related to boring and interesting learning experiences, the impact of specific sources (i.e. instructor, learner, materials, environment) on resulting boredom or interest, and the influence of a range of instructional characteristics (e.g. predictability, complexity) on student perceptions of boring and interesting instruction.

One interpretation of the results indicates that feelings of pleasure and arousal are linked to generating and sustaining current learning interest while competence and self-determination are more closely related to fostering a continuing motivation to learn (Dodge, 1990).

There are potential applications of this type of research to the development of more motivating instructional materials and interactive computer-based learning systems. For example, results of this study may also be used as motivational guidelines for the design of effective instruction. Specifically:

- *Colorful* instruction that incorporates a variety of attention-gaining and maintaining strategies appears to be the most effective for generating interest and preventing boredom.
- Instruction that incorporates surprise, novelty and variety (the major element of Keller's Attention Component) may help reduce the *predictability* that appears to promote learning boredom.
- Instructional materials (e.g. videos) that do not capture students' attention and are not directly relevant to the content and goals of the instruction may promote boredom.
- Instructors are perceived by learners as having the prime responsibility for learner interest or boredom. Therefore, instruction must be designed to include motivational strategies that enhance learner interest and reduce learner boredom. At the same time, instructors need to incorporate ways to help learners take more responsibility for their own motivation, as currently learners do not perceive themselves as potentially influencing their own boredom levels.

One of the underlying goals of instruction is to motivate students to learn. Designers of instruction strive to motivate students to: (1) want to learn, (2) enjoy learning while it is occurring, and (3) continue learning after the instruction has formally ended. Research that illuminates what instructional factors promote interest and reduce boredom will move us closer toward our goal.

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Title:

Impact of R.M. Gagné's Work on Instructional Theory

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Although it is not unusual for R.M. Gagné's work to be considered in a volume addressing learning theories, his contributions can most appropriately be considered as an "instructional theory." An instructional theory is an integrated set of principles, based upon learning theory, other relevant theories, and sound replicable research, that permits one to predict the effects of specific instructional conditions on a learner's cognitive processing and the resulting learned capabilities. Gagné (1985) described the nature of an instructional theory as an "attempt to relate the external events of instruction to the outcomes of learning by showing how these events lead to appropriate support or enhancement of internal learning processes. . . The province of an instructional theory is to propose a rationally based relationship between instructionAL events, their effects on learning processes, and the learning outcomes that are produced as a result of these processes." (p. 244) How does instructional theory relate to learning theories, instructional psychology, and instructional design models. In contrast to instructional theories that tend to be predictive and prescriptive, learning theories are typically descriptive and explanatory. According to Driscoll (1994) a learning theory "a set of constructs linking observed changes in performance with what is thought to bring about those changes." (p. 9) Instructional psychology is the study of the facilitation of human learning through instruction and can result in instructional design theories and models. Instructional design models employ instructional theories to prescribe types and levels of instructional support to optimize the achievement of identified learning goals.

Snow and Swanson (1992) suggested that the components of an instructional theory are "a) description of desired end states or goals of instruction in a domain; b) description of goal-relevant initial states of learners prior to instruction; c) explication of the transition processes from initial to desired states; d) specification of instructional conditions that promote this transition; e) assessment of performance and instructional effects." (p. 584) If we compare Gagné's instructional theory to these components we find that Gagné's theory does have these components. For example, Gagné describes potential **end goal states** in his categorization of learning capabilities. These goal states are generic in that they can apply across a variety of content areas. For each of the goal types Gagné described **goal-relevant initial states**, prerequisite relationship of intellectual skills and relationships of other types of learning. Gagné interpreted information processing theory to explicate the **transition processes** from initial to goal states for each type of learning. Gagné's greatest impact on instructional theory may be his thoroughness in specifying **instructional conditions** to support this transition process. He described these instructional conditions both as generalized events of instruction and as specific conditions of learning for each type of learning capability (Conditions of Learning, 1965, 1970, 1977, 1985) Finally, Gagné and his colleagues extended his thorough explication of learning outcomes into recommendations for **assessment** within each category (Gagné & Beard, 1978; Gagné, Briggs, & Wager, 1992).

Although Gagné was the first theorist to bring this elements together into an instructional theory, as with all learning/instructional theorists, his work was strongly influenced by the theorists who preceded him. To gain an adequate perspective of Gagné's influence on instructional theory, we must first survey the status of instructional theory prior to Gagné's influence.

Status of Instructional Theory Before Gagné

The need for instructional theory has long been recognized, and as early as 1899, William James pointed out that, as important as psychology is to education, it is not something from which the nature of the instruction may be directly induced: "You make a great, a very great mistake, if you think that psychology, being a science of the mind's laws, is something from which you can deduce definite programmes and schemes and methods of instruction for immediate schoolroom use" (James, 1899/1958. p. 23). Instructional theory remained an elusive topic before Gagné's contributions of the early 1960's. Two primary avenues of thought regarding instructional theory in the decade or so prior to Gagné's major contributions were a focus on: a) sequence and content concerns from within a curriculum theory frame of reference, and b) application of learning theory, particularly applications within a programmed instruction frame of reference.

Curriculum Theory. Much work that characterizes the status of instructional theory before Gagné is seen in the work of curriculum theorists. People such as Bruner and Tyler are among those whose work concentrated on matters of sequence and the content of learning. Bruner's (1960) concept of the spiral curriculum and Tyler's conception of the "rationale" for a course as its design beginning point (1950) are examples of curriculum thinkers' contributions to instructional thinking.

One persistent pattern in curriculum thinkers' approaches to instruction is to place primary emphasis upon teaching. Hosford (1973), for example, defined curriculum, instruction, and teaching much as an instructional systems specialist or instructional technologist might, but he insisted on placing teaching at the center of his conception of instruction and, in subsequent treatment of a theory of instruction, made the continued assumption that teaching and teachers would be the primary (or only) means of implementation. Such a focus on teaching, it appears, prevents curriculum theorists from thinking vigorously and directly about instruction itself. Nonetheless, for better or worse, the more philosophical contributions from curriculum thinkers formed a substantial proportion of instructional theory.

Bruner's widely recognized work in instructional theory (1968) proposed four criteria that an instructional theory should meet. An adequate theory of instruction, according to Bruner, would provide the basis for specification of: a) experiences which will induce motivation to learn, b) optimal structures of knowledge for learning, c) optimal sequences of encounter; and d) the nature and pacing of rewards and punishments. In many regards Bruner's widely heralded work seems now naive and quaint. His concentration on structures of knowledge within disciplines at the expense of treatment of form of encounter and his treatment of intrinsic motivation within a category labeled "rewards and punishments" are reflections of a teaching-centered view of instruction.

In a less widely recognized but at least equally valuable contemporary work to Bruner's, Gordon (1968) presented a relatively mature view of instruction and instructional theory. Gordon defined a theory of instruction as "a set of statements, based on replicable research, which would permit one to predict how particular changes in the educational environment (classroom setting) would affect pupil learning." (p. 3) Gordon differentiated the terms "instruction" and "teaching" by noting that teaching "refers primarily to the human interaction between teacher and pupil" (p. 3) and instruction as the more encompassing term, referring to "the activity which takes place during instruction and within the classroom setting. The term includes both material and human variables." (p. 3). The distinctions that Gordon made between instruction and teaching are useful ones, as the study of instruction and the study of teaching are reflected separate bodies of literature as well as distinct traditions of interest and inquiry. However, reflecting the curriculum and teaching methods orientation, Gordon restricted his conception of instruction to classroom activities, a restriction that might be viewed as limiting by current instructional theorists.

Before Gagné's work had become widely recognized (and, of course, remaining conventional in many Education specialties today) many authorities believed that the most important instructional considerations lay within the structures of subject matter disciplines and the interface of those structures with broad developmental characteristics of learners. The structures of knowledge within the various disciplines--science, mathematics, history, and so on--was (and is) seen to vary radically from discipline to discipline in conceptual, syntactical, and substantive ways (Ford & Pugno, 1964; Phi Delta Kappa, 1964). Gagné brought a sufficiency of scholarship to questions of learning from instruction that arise from the psychological requirements of learning tasks, as opposed to questions which arise from parent disciplines from which subject matter comes, to yield prescriptive principles which--though not universally adopted in educational theory have had a substantial impact upon theory and research that have examined educational practice.

Applied Learning Theory. Although typically involving itself with animal conditioning experiments, the mainstreams of learning psychology in the first half of the twentieth century, exemplified by Guthrie, Skinner, and Hull, were deeply concerned with human learning. Guthrie's association-centered theory (Guthrie, 1935, 1942) gave rise to Sheffield's (1961) work in learning complex sequential tasks and Lumsdaine's (1961) training research on effects of cueing. Skinner's operant conditioning saw application by Skinner (1954) and Holland (1960). Hull's detailed, systematic, and quantified approach to learning based on drive-reduction led to instructionally-relevant research on feedback by Miller and Dollard (1941).

Clearly, learning theory was in disarray when Hilgard wrote the concluding chapter to Theories of Learning (Hilgard, 1948): "We need a more careful delineation of the kinds of learning which take place.... This search for the appropriate concepts is not merely an exercise in definition or classification. It requires a high order of theory construction, based on open-minded acceptance of demonstrable relationships." (p. 326-327) Almost 30 years later, the concluding chapter in the fourth edition of that work (Hilgard & Bower, 1978) was entitled "Instructional Theory." The first reference cited in that chapter is the first review of instructional psychology in Annual Reviews by Gagné and Rohwer (1969). Hilgard and Bower described Gagné's work to that time as one of three models that provide "indications

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of what is to come." (1978, p. 614). In addition to Gagné's "hierarchical theory," Bruner's "cognitive-developmental theory" and Atkinson's "decision-theoretic analysis for optimizing learning" are described. Of these, although important subsequent work was done by all three, Gagné appears to have gone the furthest toward development of a full instructional theory.

A great deal of interest in the 1950's was generated by the innovation called "programmed instruction." Embodied in both teaching-machine and text-based forms, programmed instruction carried with it ideas of far greater importance than the competing specific forms and rules dictating format that were matters of heated debate at the time. With programmed instruction, an agency other than a person was seen as an instrument of instruction. Previously, all non-human tools including books, television, and the various forms of audiovisual media, were conceptualized as aids or resources for a teacher's use. Even the powerful medium of motion pictures (and later television) was viewed as something that had "classroom" uses, which required a teacher's introduction and follow-up for meaningful learning to anticipated.

This radical change in view of the potential of instructional media brought with it a radical change in what might be studied as "instruction" and how research on it might be conducted. In his landmark review, "Instruments and Media of Instruction," Lumsdaine (1963) pointed out the significance of the ideas behind programmed instruction for thinking about research on instruction: "...the control of learner behavior and feedback which is provided by the continuous record of student response from auto-instructional programs may afford the most promising vehicle yet developed for the analytic experimental student of variables affecting human learning (as well as for the incorporation of research findings in improved instruments)." (Lumsdaine, 1963, p. 608) Research on programmed instruction brought with it, perhaps unknowingly but certainly inevitably, focused concern on matters of form of encounter with material to be learned outside the frame of reference of "teaching." As teaching itself is not a reproducible event, the study of teaching has focused on matters that can be of ultimate utility in understanding the role of teachers, understanding the teaching act, and understanding interactions among teachers, learners, and activities. When studying instruction using agencies providing sequenced and reproducible events, controlled investigations of form of encounter became practicable. An enormous corpus of research was developed during the 1950's and 1960's under the programmed instruction umbrella on areas such as practice, feedback, sequence, and criterion-referenced assessment.

One example of how work in programmed instruction contributed to instructional theory can be seen in "validation" procedures for programmed instruction. The first work in what would now be labeled "formative evaluation" was developed under the notion of "how should programmed instruction be validated?" Procedures for the development and establishment of known quality in programmed instruction materials have evolved over the years to include instruction in any form and are the basis of current formative evaluation principles and procedures. Other examples can be seen in studies on such areas as instructional feedback, instructional event sequencing, pacing, optimal prompting of practice, and forms of practice and response.

Other cornerstones of contemporary instructional design practice, such as use of performance objectives, have their roots in programmed instruction. However, the generalization which transpired between thinking of "how to best implement a particular programmed instruction format" on the one hand and "how to optimally conduct instruction" on the other, is not a trivial one. Gradually attention began to shift from the procedural details to variables, questions, and models of instruction that would underlie the techniques. No one contributed more to this shift in thinking--much of his own work in the 1950's and early 1960's can be seen as an embodiment of it--than Robert Gagné.

Precursors to Instructional Theory

Of the schools of thought that underlie instructional theory, Gagné clearly comes from the "applied science" perspective. As a psychologist, he studied learning in demanding, realistic settings, and was, in fact, somewhat impatient with colleagues whose purity of purpose prevented their doing the more messy and often less clear applied research that instructional theory-building requires. In a review of factors that contribute to learning efficiency for a volume on programmed instruction sponsored by the Air Force Office of Scientific Research, Gagné and Bolles noted that "the learning tasks that have been most intensively studied by psychologists have been of an artificial "laboratory" variety; relatively little is known about learning in real life situations." (Gagné & Bolles, 1959, 13-14)

Training research in the 1950's put Gagné in touch with a wide variety of instructional problems, representing a wide variety of learning tasks. Illustrative studies in the literature are Gagné (1954) "An Analysis of Two Problem Solving Activities" involving troubleshooting and interpretation of aerial photographs, and Gagné, Baker, & Wylie (1951) "Effects of an Interfering Task on the Learning of a Complex Motor Skill" involving manipulations of controls similar to aircraft controls. In a review of problem-solving and thinking, Gagné pointed out the relevance of trouble shooting studies to issues in concept formation (Gagné, 1959). Wide and vigorous participation in research on learning and instruction in the military environment, along with his thorough and rigorous background as a learning psychologist, may have created the dissonance that motivated Gagné to develop the concepts of conditions of learning, learning hierarchies, events of instruction, and types of learning. In the following pages, we will discuss each of these three contributions to instructional theory.

Instructional Theory Contributions

Gagné developed four major propositions that constitute his instructional theory:

a) Learning goals can be categorized as to learning outcome or knowledge type;
b) Acquisition of different outcome categories requires different internal processes;
c) Learning outcomes can be represented in a predictable prerequisite relationship;
d) Acquisition of different outcome categories requires identifiably different instructional processes.

Development of Types of Learning. Gagné was, of course, not the first theorist to suggest that all learning is not alike, that learning might be analyzed into different types of learning. Indeed, as early as 1933 Carr suggested classes of experimental learning tasks and warned that principles that had been derived about one set of tasks could not necessarily be generalized to other classes (Melton, 1964). In the 1940's scientists such as Melton (1941) and Tolman (1949) continued the efforts to categorize learning types. During an informal meeting of college examiners at the 1948 American Psychological Association conference, Bloom and his colleagues discussed the need for a set of common descriptors of learning to facilitate communication among them. This effort resulted in "Bloom's Taxonomy" of cognitive educational objectives (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) and Krathwohl's taxonomy of affective educational objectives (Krathwohl, Bloom, & Masia, 1964). Despite the original intention of these taxonomies to standardize terminology, they readily assumed the stature of psychologically-based correlates.

In 1962, Melton organized a "Symposium on the Psychology of Human Learning" that was held at the University of Michigan at Ann Arbor. The focus of the symposium was to discuss "the interrelationship of different categories of human learning." (p. vii) Melton later edited a book Categories of Human Learning (1964) that compiled many of the papers from this symposium. Among these was Robert Gagné's chapter "Problem Solving." In this chapter Gagné presented a table entitled "A Suggested Ordering of the Types of Human Learning" in which he proposed the following six types of learning: Response learning, chaining, verbal learning (paired-associates), concept learning, principle learning, problem solving (Gagné, 1964, p. 312). Gagné did not cite a previous publication related to these concepts, so this chapter may be the first appearance of his types of learning outcomes categories. In this chapter he began to differentiate between verbal learning and "nonreproductive" types of learning, such as concept learning and problem solving. This differentiation eventually led to his separate domains of learning of "verbal learning" and "intellectual skills."

Gagné presented the first complete statement of the types of learning conception in his first edition of The Conditions of Learning (Gagné; 1965). He began by reviewing learning theory and research, such as James, Dewey, Watson, Thorndike, Tolman, Ebbinghaus, Pavlov, and Köhler, introducing the idea of types of learning, with the notion of "learning prototypes,"

> Throughout the period of scientific investigation of learning there has been frequent recourse to certain typical experimental situations to serve as prototypes for learning. . . . These learning prototypes all have a similar history in this respect: each of them started to be a representative of a particular variety of learning situation. Thorndike wanted to study animal association. Pavlov was studying reflexes. Ebbinghaus studied the memorization of verbal lists. Köhler was studying the solving of problems by animals. By some peculiar semantic process, these examples became prototypes of learning, and thus were considered to represent the domain of learning as a whole, or at least in large part. (p. 18-19)

Gagné (1965) presented eight types of learning in the first edition, in a rather strict hierarchical relationship. He described all types but the first, signal learning (classical conditioning), as having prerequisite relationships with one another. Gagné carefully referenced researchers that had examined these eight types of learning:

1. Signal learning (Pavlov, 1927)
2. Stimulus-Response learning (Thorndike, 1989; Skinner, 1938; Kimble, 1961)
3. Chaining (Skinner, 1938; Gilbert, 1962)
4. Verbal Association (Underwood, 1964)
5. Multiple Discrimination (Postman, 1961)
6. Concept Learning (Kendler, 1964)
7. Principle Learning (Gagné, 1964)
8. Problem Solving (Katona, 1940; Maier, 1930) (pp. 58-59)

This list remained relatively unchanged in the second edition of Conditions of Learning (1970). By the third edition (Gagné, 1977), Gagné added information processing theories to the treatment of learning prototypes, recasting the types of learning to some degree by their different cognitive demands . In addition, an increasing influence of task characteristics, rather than psychological processes guided the form and content of the types of learning. In its latest form as of this writing (Fourth Edition, Gagné, 1985), he identified distinctly different categories within the domain of intellectual skills: discriminations, concepts, rules, and higher-order rules (domain-specific problem-solving). He proposed that these knowledge types are in a prerequisite, vertical transfer relationship, with discriminations prerequisite to concepts, concepts, prerequisite to rules, and rules prerequisite to problem solving. The types of learning in the fourth edition are:

1. Intellectual Skills
    discriminations
    concepts
    rules
    problem solving
2. Cognitive Strategies
3. Verbal Information
4. Motor Skills
5. Attitudes

(Gagné later pointed out that the verbal information category could also be termed "declarative knowledge" and the intellectual skills category could be termed "procedural knowledge.")

More recently, Gagné and Merrill (1990) identified another category, which they termed "enterprise." They described this category as being substantively different from the other learning outcomes that Gagné or Merrill had previously identified, requiring the integration of the other more simple learning outcomes, such as rules, concepts, and declarative knowledge.

There are two ways in which one might view these outcomes: as descriptions of tasks (with external, "task-related" differences) or are they descriptions of learned abilities (with differences arising out of distinctive processing or memory structures)? Gagné has tended to define these outcomes as the latter, describing them as "learned dispositions," "capabilities," or "long term memory states," (1985, p. 245). He described verbal information and intellectual skills as having distinctly different memory storage systems, consistent with those of other theorists, such as Anderson (1990). An empirical basis for the "verbal information" knowledge to be stored as propositional networks is provided by Gagné and White (1978). Rule-using is described by Gagné and White as stored in hierarchical skill structures which they referred to as "intellectual skills." Verbal information has been described more recently by Gagné (1985) as being stored as propositional networks or schemata. He described rules, including concepts (defining rules), as being stored as "if.. then" productions. The storage of problem solving capabilities themselves was not addressed, although interconnections of schemata and productions were implied. The storage mechanisms of attitudes, motor skills, or cognitive strategies are also not explicitly discussed.

Gagné's categorization of learning outcomes has not been without it critics. Although Gagné characterized his categorization system as more internally, than externally derived, Kyllonen and Schute (1989) viewed Gagné's categorization of learning types as a "rational taxonomy," developed via proposing "task categories in terms of characteristics that will foster or inhibit learned performance." (p. 120) They suggested that the limitation of such categories is that their basis is not psychological processes and, therefore, such processes are unsystematically considered.

Development of the Learning Hierarchies Concept. Perhaps as significant as his delineation of categories of learning, is Gagné's conception of a learning hierarchy. Although this hierarchical relationship was implied in the taxonomies of a number of theorists (Cotterman, 1959; Demaree, 1961; Lumsdaine, 1960; Miller, 1962; Parker & Downs, 1961; Stolurow, 1964; Willis and Patterson, 1961), it was Gagné who brought the conception of "learning hierarchy" clearly into focus with his statements regarding the nature of these relationships and his research to validate these principles.

Gagné's first references to "learning hierarchies" appears in articles published in 1962, a report of a study, "Factors in Acquiring Knowledge of a Mathematical Task" (Gagné, Mayor, Garstens, and Paradise, 1962) and another study, "The Acquisition of Knowledge," (Gagné, 1962) which involved similar learning tasks. These reports were preceded by a Gagné and Paradise's 1961 study, which formed a foundation for the latter studies. In 1961, Gagné and Paradise found support for the proposition that transfer of learning from subordinate sets of learning tasks could account for performance in a terminal learning task. In a subsequent study, Gagné, Mayor, Garstens, and Paradise (1962) sought to extend and confirm the validity of the idea of the "learning hierarchy." In this study, the posttest supplied information about achievement of not only the terminal task (adding integers) but also the 12 prerequisite learning sets, each scored as "pass" or "fail." Success in final task achievement correlated highly with the number of subordinate tasks successfully achieved for both of the two terminal learning tasks (.87 and .88). Patterns of transfer among the subordinate tasks also conformed to theoretical predictions of a learning hierarchy.

In 1973, Gagné fully described learning hierarchies as having the following characteristics: They a) describe "successively achievable intellectual skills, each of which is stated as a performance class; " b) do not include "verbal information, cognitive strategies, motivational factors, or performance sets;" and c) describe "only those prerequisite skills that must be recalled at the moment of learning" to supply the necessary "internal" component of the total learning situation. (p. 21-22)

White (1973) reviewed a number of studies that attempted to validate learning hierarchies developed according to Gagné's principles. He found none that had a perfect match with predicted prerequisite relationships. However, he suggested that many of the studies were seriously flawed by imprecise specification of prerequisite tasks, using only one item per prerequisite task, small sample sizes, and other methodological problems. Research has continued both on methodologies to validate hierarchies and techniques for specifying hierarchies (e.g., Airasian & Bart, 1975; Cotton, Gallagher, & Marshall, 1977; Griffins, 1983; Kee & White, 1979; Wilson, 1989; Winkles, 1986). For example, Winkles (1986) investigated the learning of trigonometry skills with a learning hierarchy validation study, identifying both lateral and vertical transfer. Two experiments with eighth and ninth-grade students involved instructional treatments described as "achievement with understanding" and "achievement only." Results reported "achievement with understanding treatment is better for the development of lateral transfer for most students, and of vertical transfer for the more mathematically able students, whereas the differences between the treatment groups on tests of achievement and retention of taught skills are not significant. A small amount of additional instruction on vertical transfer items produces much better performance under both treatments." (p. 275)

Development of Events of Instruction. In 1962, in addition to presenting the "learning hierarchies" concept, Gagné also introduced began to consider features that should be included in the instructional situation, such as description of the required terminal performance and provision of "guidance of thinking." Then, in the first edition of The Conditions of Learning (1965) Gagné included a section headed "component functions of the instructional situation"

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which, except for its label, is basically identical to the "events of instruction" seen in later editions of The Conditions of Learning. The eight functions were a) presenting the stimulus, b) directing attention and other learner activities, c) providing a model for terminal performance, d) furnishing external prompts, e) guiding the direction of thinking, f) inducing transfer of knowledge, g) assessing learning attainments, and h) providing feedback. In the second edition of The Conditions of Learning (Gagné, 1970), Gagné added "The Events of Instruction" to a new chapter entitled "The Design of Instruction," completing the development of the fundamental concept of "the events of instruction."

Although researchers have expended much effort in investigating the optimal nature of individual events (e.g., feedback research, research on objectives), the validity of events of instruction as a whole have not been subjected to much research. This must in part be due to Gagné's assertion that instruction must not necessarily include all events on all occasions, as learners are often able to supply the processing that the events evoke without external prompting. The authors did, however, find one study that examined the effectiveness of the events in instruction for high school students on the use of quotation marks (Coats, 1985). The experimental study involved three treatments: a) all nine events; b) only four events: presenting stimulus materials, providing learning guidance, eliciting performance and providing feedback, and c) the same events as in treatment b with more elaborate eliciting performance and feedback events. The results indicated no main effects for treatments, but an interaction between ability and treatment: High ability learners performed better under treatment b; low ability learners under treatment c. It is really no surprise that by high school the students did not need much introduction to quotation marks, that are represented by the early events of instruction. Nor is it a surprise that the low ability learners performed better under a condition that required more practice and feedback.

Conditions of Learning. Perhaps more than the explication of categories of learning capabilities and the events of instruction, Gagné's major contribution to instructional theory lies in his suggestion that for each category or subcategory of learning capability to be acquired, certain internal conditions must be met. His attention to the conditions within the learner has been long-lasting, as he has conjectured about necessary conditions within the learner since his first edition of Conditions of Learning (1965). He further suggested from this first edition that these internal conditions vary somewhat by learning capability. Specifically, he has proposed in more recent years that the internal events that may differ most across learning capabilities are "a) substantive type of relevant prior knowledge, b) manner of encoding into long term storage, c) requirement for retrieval and transfer to new situations." (1984, p. 514) It should be noted that in Gagné's detailing of the internal conditions of each type of learning, the major internal condition that he details is prerequisite knowledge. Gagné used an information-processing model including processes of attention, selective perception, semantic encoding, retrieval, response organization, control processes, and expectancies to contextualize these cognitive processes.

He, therefore, in his 1985 edition of Conditions of Learning pointed out that the events that may differ most significantly from learning category to learning category are those corresponding to the above three internal events: These external events are a) stimulating recall of prior knowledge, b) providing learning guidance, and c) enhancing retention and transfer.

As an instructional psychologist, Gagné was particularly interested in the external conditions that might occur or could be provided to "activate and support" the internal processing necessary for learning to occur (1985, p. 276). In fact, Gagné defined the purpose of instructional theory as "to propose a rationally based relationship between instructional events, their effects on learning processes, and the learning outcomes that are produced as a result of these processes." (1985, p. 244) Therefore, Gagné derived the external events from the internal events of information processing.

Gagné particularized the general external events, the "events of instruction," that begin to be described in his work in 1962 to specific prescriptions for external conditions for each type of learning, event by event, for each of the categories of learned capability. Much of these external conditions is logically derived from the intersection of the function of the external event (those cognitive processes that it supports) and the nature of the learning capability. He labeled these external supports for each type of learning as their "(external) conditions of learning."

Gagné and Glaser (1987) included an excellent summary of hypothesized differential learning conditions for types of learning.

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Table 7-1. Gagné and Glasser's Learning Categories X Conditions Summary

Effective learning conditions
for categories of learned capabilities

Type of Capability	Learning Conditions
Intellectual skill	Retrieval of subordinate (component) skills Guidance by verbal or other means Demonstration of applic. by student; precise feedback Spaced reviews
Verbal information	Retrieval of context of meaningful information Performance of reconstructing new knowledge; feedback
Cognitive strategy (problem solving)	Retrieval of relevant rules & concepts Successive presentation (usually over extended time) of novel problem situations Demonstration of solution by student
Attitude	Retrieval of information and intell. skills relevant to targeted personal actions Establishment or recall of respect for human model Reinforcement for personal action either by successful direct experience or vicariously by observation of espected person
Motor Skill	Retrieval of component motor chains Establishment or recall of executive sub-routines Practice of total skill; precise feedback.

(Gagné & Glaser, 1987, p. 64)

Unfortunately, there has not been systematic research investigating the validity of the principles for external conditions for specific types of instruction as suggested by Gagné. However, there are some lines of research that have suggested that his underlying premise that different types of learning are facilitated by different instructional conditions. For example, a meta-analysis by Schimmel (1983) suggested that feedback may be more potent for intellectual skills objectives than for verbal information objectives. In addition, Schimmel found that confirmation feedback was more useful than correct answer feedback for verbal information outcomes. However, he did not find this superiority of confirmation feedback for intellectual skills objectives. Research on the value of providing learners with objectives reveals another example of research that may support Gagné's principles of conditions of learning. Hartley and Davies (1976) found that providing objectives benefited students when the learning task is an intellectual skill, but was not significantly beneficial to promote verbal information learning. Although these findings are in no way comprehensive, they do provide some validation of an outcomes by conditions theory of instruction.

The Relationship of Gagné's Work to Learning Theory

Gagné's work is not easily related to a single learning theory base. His early work, frequently characterized as behaviorist, might better be considered more broadly as associationist. Within the associationist tradition, his work appears to fit better within the functionalist group than either the behaviorist or connectionist. However, the integrative nature of his work, particularly as reflected in the first edition of Conditions of Learning, transcended the traditional categories of learning theory. An examination of the sources for the eight categories of learning identified in this first edition reveals origins in field theory (from gestalt psychology) as well as functionalism and behaviorism. The range of learning types that he wished to consider were not adequately examined under any single theory at that time, so he had to examine a number of learning theories in order to develop his instructional theory.

Certainly, by the first edition of Conditions of Learning (1965), Gagné was beginning to conjecture about the internal conditions of the learner. And, by the second edition, he used an information processing model (although it is not labeled as such) to describe the cognitive processes that occur during a "learning sequence." (1970, pp. 70-71) In the third edition of Conditions of Learning (1977), Gagné's instructional theory was thoroughly integrated with information processing theory. Although he employed other theories, as appropriate. Gagné has continued to draw substantially from information processing theory, one of the family of cognitive learning theories, as his basis for describing the internal processes and structures of learning that are affected by the external conditions and events of instruction.

One frequently finds Gagné's work described as behaviorist, associationist, as well as cognitivist. Indeed, it is difficult to utilize a single learning theory with which to characterize his work. An attribute of Gagné's theory that makes it so difficult to accurately categorize is that although his theory base was eclectic in source it was unified in result. Hilgard and Bower pointed out that Gagné's work "is not strictly an eclectic theory (which chooses good principles from here and there without any order among them), but is the beginning of a unified theory. " (1966, p. 569). And that result, an instructional theory, even in its earliest versions is not well-classified as behaviorist or even associationist psychology. Gagné's theory as reflected in later editions of Conditions of Learning moved even further from the associationist perspective and became increasingly based on cognitive psychology, with an information processing emphasis. Perhaps the source of the difficulty in classifying Gagné's theory arises from attempts to classify it under the categorization system of learning theories, when it is in effect an instructional theory that proposes facilitating instructional conditions for a range of learning types from declarative knowledge to psychomotor skills to attitudes. No single learning theory at this time appears to adequately explain or predict all of these types of learning. Hence, an eclectic learning theory base for Gagné's instructional theory is entirely appropriate.

Influences of Gagné's Theory on Instructional Design Models

Gagné's theory has been foundational in providing the basis of what can be termed "conditions-based" models of instructional design. Conditions-based models are predicated upon the propositions that (a) learning can be classified into categories that require similar cognitive processes for learning ("internal conditions of learning") and, therefore, (b) within these categories of learning similar instructional supports are needed to facilitate learning ("external conditions of learning"). Conditions-based models of design which are derivative of Gagné's work include those by Merrill (1983), Reigeluth (1979), Merrill, Li, and Jones (1990a & b), and Smith and Ragan (1993).

In the early 1970's, M.D. Merrill developed a conditions-based model for instructional design called "component display theory." Merrill noted that component display theory evolved from his interactions with students studying Gagné and that "CDT is founded on the same assumption as Gagné's work--namely that there are different categories of outcomes and that each of these categories requires a different procedure for assessing achievement and a different procedure for promoting the capability represented by the category." (Merrill, 1983, p. 284-285) Early work describing most of the elements of CDT appears in Merrill and Boutwell (1973). CDT classifies objectives in a two-dimensional matrix made up of three performance levels and four content types. This 12-category system differs from Gagné's in that instead of having a declarative knowledge category, as Gagné does, which would include remembering facts, concept definitions, rule statements, and procedural steps, CDT provides separate categories for each of these types of declarative knowledge. And, instead of having a single category for cognitive strategies, as Gagné does, CDT proposes "find" operations for each of the content types: Find a fact, find a concept, find a rule, and find a procedure. CDT also includes a treatment of external conditions for learning as "presentation forms," including content (generality or instance), and approach (expository or inquisitory) as primary forms and, for secondary presentation forms, elaborations such as context, prerequisite, mnemonic, mathemagenic help, representation or alternative representation, and feedback. The idea of presentation forms relating to different categories of learning appears to be an elaboration of Gagné's conceptions of external conditions for learning.

Pinning down differences and similarities between Merrill's CDT and Gagné's types of learning represents something of a moving target because both systems have changed over the years. For example, Gagné's "types of learning" evolved into a very different form from that which was presented in 1965. In general, the types of learning evolved to keep up with changing knowledge about learning and cognition as well as different ideas about learning from instruction which were being developed by contemporaries. We can speculate that some of the impetus for change in Gagné's types of learning during the 1970's may have come from ideas such as Merrill's component-display theory.

C.M. Reigeluth developed a model for instructional design, "the "elaboration theory," during the late 1970's (Reigeluth, 1979). As an extension of Merrill's component display theory, elaboration theory may be seen as a "grandchild" of Gagné's seminal work. Elaboration theory takes a broader view than CDT and provides guidance for the design of instruction for complex, unfamiliar, multi-topic content rather than prescribing the form of encounter for individual lessons. The conditions-based nature of the model is seen in Reigeluth's specification of three differing structures, conceptual, procedural, or theoretical, which are selected based upon the goals of the course. Later development by Reigeluth includes the "simplifying conditions model" which retains a conditions-based orientation by suggesting that different simplifying conditions structures need to be developed for each of the kinds of knowledge structures described (Reigeluth & Rogers, 1980; Reigeluth, 1992).

In part an extension of CDT, Merrill and associates have formulated a model for instructional design ,which also has links to Gagné's work, entitled "ID^2" - a "second-generation" instructional design model (Merrill, Li, and Jones,1990a, 1990b). In large measure, ID^2 was developed to assist in the development of an expert system for instructional design, "ID Expert." ID^2 vigorously extends the basic conditions model, making more explicit the theorized relationship between learning outcomes and internal/external conditions of learning:

> a) A given learned performance results from a given organized and elaborated cognitive structure, which we will call a mental model. Different learning outcomes require different types of mental models; b) the construction of a mental model by a learner is facilitated by instruction that explicitly organizes and elaborates the knowledge being taught, during the instruction; c) there are different organizations and elaborations of knowledge required to promote different learning outcomes. (Merrill, Li, & Jones, 1990b, p. 8)

Smith and Ragan (1993) developed an approach to the design of instruction that exemplifies and elaborates Gagné's theory. Using Gagné's types of learning, they postulated a generalized cognitive process necessary for the acquisition of each of the different learning capabilities, thereby deriving a system of instructional strategy recommendations for different types of learning. Smith and Ragan also suggested that the events of instruction as Gagné portrayed them insufficiently considered learner-generated and learner-initiated learning, and restated the events so that they could readily be perceived as either learner-supplied, in the form of learning strategies, or instruction-supported, in the form of instructional strategies.

Smith and Ragan have proposed a model–Comparison of Generative/ Supplantive Strategy (COGSS)– for determining the balance between instructional strategies (instruction-supplied events) and learning strategies (learner-supplied events) based upon context, learner, and task variables. They also proposed that there is a "middle ground" between instruction supplied, supplantive (also know as "mathemagenic") events and learner-initiated events, in which the instruction facilitates or prompts the learner to provide the cognitive processing necessary to an instructional event.

Gagné's instructional theory has spawned at least two generations of instructional design theories that have concretized, elaborated, and exemplified Gagné's conditions-based propositions. However, his influence has extended beyond instructional design theory into other areas of educational design, including curriculum design.

Influences of Gagné's Theory on Curriculum Design

Although Gagné's work was directed at the study of instruction, not at teaching or curriculum, a substantial influence from his ideas can be observed in those fields. Sometimes harboring conceptions fundamentally hostile to ideas grounded in learning theory, the curriculum and teaching methods traditions represent a "tough audience" for Gagné. However, as early as 1966 W.B. Ragan, a curriculum theorist whose Modern Elementary Curriculum was an influential text for more than 25 years, made extensive use Gagné's ideas in its explanation of learning. A survey of more recent curriculum texts found some evidence of impact of Gagné's ideas, such as the importance of consideration of types of learning when determining an instructional approach. For example, Pratt (1980) prescribed the matching of instruction with objectives, classifying objectives as knowledge, skills, physical development, dispositions, and experiences. With the exception of "experiences," Pratt's categories of objectives are a close fit to Gagné's types of learning. Indeed, in Pratt's chapter describing these objective categories, he cited Gagné and provided information on intellectual skills from Gagné and Briggs (1979). The basic approach that Pratt recommended, deriving plans for the form of instruction from (among other sources) the different demands placed on learners in achieving different sorts of objectives, is a solid application of Gagné's thinking.

Posner and Rudnitsky (1994) proposed a learning task categorization scheme very similar to Gagné's: Employing understandings (cognitive and affective), and skills (cognitive skills, psychomotor-perceptual skills, affective skills). They cited Gagné as one of the sources of their categorization scheme. In another text, Robinson, Ross, and White (1985) identified different "growth schemes" for different types of learning: inquiry skills, knowledge outcomes, affective outcomes. This idea of tying different educational experiences to different types of learning is very much in the Gagné tradition.

Too often, unfortunately, curriculum theorists badly misinterpret Gagné's ideas or represent early work as if it reflects his current thinking. In citing a 1967 definition of curriculum offered by Gagné, Tanner and Tanner (1980) noted that Gagné's definition "assumes that learning is mechanical and linear, and that the learner is a mere mechanism to be conditioned toward making the right automatic responses." (p. 26). The quote to which Tanner and Tanner are responding , is within a discussion of cumulative learning effect from mastery of prerequisite learnings, "curriculum is a sequence of content units arranged in such a way that the learning of each unit may be accomplished as a single act, provided that the capabilities described a specified prior units (in the sequence) have already been mastered by the learner." (Gagné, 1967, p. 23). Perhaps in retribution for such a simplistic definition of curriculum, Tanner and Tanner provided a characterization of Gagné's approach as being based on conditioning and "right responses." This interpretation is totally inaccurate. In addition, it is dismaying that in writing a 1980 text that the authors chose to refer to a 1967 publication of Gagné's work, rather than to refer to the most recent edition of Conditions of Learning (1977) that would have more accurately reflected Gagné's position at the time.[1]

In a more friendly discussion, but still inappropriate classification, Gagné's work was characterized as "social behaviorist" by Schubert (1986). The research methodology works of Campbell and Stanley (1966) and Kerlinger (1973) were also placed in this category, so use of the term "behaviorist" is apparently an original one, referring essentially to any "scientific" approach to education. Schubert's discussions of Gagné's work are not trivializing, however, and represent a thoughtful and informed application from a curriculum perspective.

Conclusion

As described in the discussions of Gagné's major theoretical contributions, Gagné has developed, refined, and extended his theory over time. This continuing development based upon new theory and research, distinguishes him among scholars in educational/instructional psychology. His instructional theory fulfills many of Snow and Swanson's criteria that were presented at the beginning of this chapter as components of an instructional theory

a) description of desired end states or goals of instruction -- Gagné's types of learning;
b) description of goal-relevant initial learner states -- Gagné's prerequisite analysis via learning hierarchies;
c) description of the transition processes -- Gagné's internal conditions of learning;

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[1] The propensity to cite "intellectually dated," rather than available and more recent work that would more accurately represent the current development of Gagné's theory is distressingly common in not just the curriculum theory literature, but in many sources that cite his work. Another example of such a problem is found in Bower and Hilgard's learning theory text (1981), which states that Gagné is (note present tense) an associationist and cites a 1970 edition of Conditions of Learning. In some cases these statements and dated citations may be results of simple oversights, sloppy scholarship. In other cases they appear to be intentional in order to misrepresent Gagné's work and position. Such distortions are reprehensible and violate the very core of what constitutes "good scholarship." These misrepresentations are made all the more unjust by their targeting the work of a scholar who has for many been the very personification of a "life-long scholar." His work has developed continually throughout his professional life as he examined his position and responded with thoughtful revisions of his ideas. He has also been meticulous in *his* citation of the work of others. In addition, such misrepresentation has created no end of difficulty for those in our field, as communication with colleagues and students who have read such misrepresentations can be difficult, time-consuming, and even embarrassing to some who are involved.

d) detailing of instructional conditions that promote this transition -- Gagné's external conditions of learning;
e) assessment of performance and instructional effects -- Gagné and Briggs explication of appropriate assessment technology.

Gagné has left some questions for future researchers and theorists to work out. One of these areas is in the description of the transition processes between novice and experts. Gagné has carefully defined some of these internal conditions, particularly prerequisite knowledge states. It is left to others to delineate these processes more completely for the various learning types through careful empirical validation. A second area is the clear explication of the relationships between required internal processes and external conditions of learning. Within this study may be the examination of necessary versus sufficient conditions to support internal processing. A third area of extension might be a further examination of the relationship between declarative knowledge and intellectual skills. There appears to be ample evidence to support the conclusion that the ability to state the generalities underlying intellectual skills is not prerequisite to the learning of intellectual skills. However, it is still unclear whether some other aspect of the declarative nature of intellectual skills might be prerequisite. A test of the robustness of a theory is not only the number of questions it answers, but also the number of questions is spawns. Gagné's instructional theory is fertile with substance to be examined by future scholars.

It is difficult to overestimate the impact R.M. Gagné has had on instructional theory. Although his has not been the only important voice in shaping the field, it has been an enormously influential one by virtue of the prodigious volume of original work which is at once bold in its conceptions and careful in scholarship. This combination of thoroughly grounded yet vigorously inventive work has left a legacy for a field of study to build upon.

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Title:

The Impact of Qualitative Observational Methodology on the Authentic Assessment Process

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Introduction

What is taught, *how* it is taught, and *how* it is assessed are critical issues within the educational community today. The concerns that students in our American educational system are failing to learn critical thinking, problem-solving, and reasoning skills, and do not have the ability to transfer these skills to real-world situations have become the focus of our national educational reform agenda. In order to deal with these concerns, educators and psychologists have been researching various methods of both improving student learning and assessing student performance.

In order to acquire accurate and useful information concerning student performance, teachers are turning away from traditional summative evaluation methods toward a formative method of assessment. This method of assessment is variously known as *authentic assessment, alternative assessment,* and *performance-based assessment.* These terms are often used interchangeably, however they are not the same. According to Marzano, Pickering, & McTighe (1993) authentic assessment, popularized by Grant Wiggins (1989), conveys the idea that assessment should engage students in applying knowledge and skills in the same way they are used in the 'real world' outside of school (p.13). Alternative assessment applies to the variety of assessments that differ from the multiple-choice, timed, one-shot approaches characterized by most traditional standardized and classroom evaluation methods. Finally, performance-based assessment, according to Marzano, Pickering, & McTighe (1993) is a broad term, encompassing many of the characteristics of both authentic assessment and alternative assessment (p.13). Regardless of which definition is used, formative assessment methods require the assessor to employ heightened observational skills to gather careful and descriptive assessment data on student performance.

Observation is an important method of data gathering in authentic assessment, just as it is in qualitative research. The process of data gathering for the sake of scientific research has been traditionally thought of as the job of a full-time professional researcher. Today, however, "... research is conducted by many people in many settings" (Marriam, 1995, p.1). Page and Thomas (1977) defined research as a "...systematic investigation to increase knowledge and/or understanding" (p.290). One method of systematic qualitative research, referred to as a case study, "is an intensive description and analysis of a phenomenon or social unit such as an individual, group, institution, or community" " (Marriam, 1995, p. 108). Similarly, during an authentic assessment process the classroom teacher is involved in intensive description and analysis of a student's performance. Classroom teachers use anecdotal records, checklists, logs, journals, portfolios and interviews as authentic assessment data gathering tactics in much the same way that qualitative researchers gather data in the field. In a case study methodology, for instance, the primary aim of the systematic investigation is to describe the observed situation "in depth, in detail, in context, and holistically" (Patton, 1987, p. 19). This is also the goal of a classroom teacher engaged in the authentic assessment process. Parelleling the teacher's role in the classroom with that of a qualitative researcher places a unique perspective on the traditional view of a classroom teacher. This unique perspective expands the definition of today's classroom teachers to that of a "teacher/researcher", involved in documenting and evaluating key observable educational situations. This, in turn, results in the creation of a broader, more genuine picture of student performance and offers more opportunities for the improvement of student learning.

The use of qualitative observational methodology is a key to increasing the effectiveness of the authentic assessment process. Through consistent and systematic classroom observation, the teacher is able to gain a deeper understanding of *how* a child learns as well as the end product of the learning experience. Just as in qualitative methodology, the "observer is the instrument" (Patton, 1987, p. 12) who carefully examines trends or patterns while emphasizing "the importance of the *meaning* of human behavior and the social-cultural context of social interaction" (et al., 1987, p.20). The integration of qualitative observational methods can provide teachers with a systematic pedagogical framework in which to improve the accuracy, validity, and reliability of the authentic assessment process.

This paper focuses on a systematic method of developing an authentic assessment instrument that incorporates a three phase process of what is to be assessed, how it is to be measured, and how to interpret verbal and non-verbal messages or data.

What is to be assessed?

Prior to the implementation of any form of assessment, a clear understanding of *what is to be assessed* is necessary. This includes a fundamental understanding of the purpose of the assessment process, the learner, and the subject matter to be taught.

If the primary purpose of the assessment is to "describe the extent to which students have attained particular knowledge and skills, your assessment should focus on the outcomes or product of student learning" (Herman, Aschbacher, Winters, 1992, p.23). "However, if your purpose is diagnosis and improvement, such as diagnosing a student's strengths and weaknesses, prescribing the most appropriate instructional programs, or identifying strategies students use well and those they need help with, you'll want an assessment that gives you information about the process as well as the outcome" (et al., 1992, p.23).

Understanding and recognizing the uniqueness of learners and their learning styles is an important step in the assessment process. The multiple intelligence theory, advanced by Howard Gardner (1983), espoused a shift in philosophy in which the assessor recognizes the learner's framework of intelligence based on a broad range of abilities. Fully exploring and supporting the potential of all learners has the potential to maximize the learning experience and establish a powerful sense of self-confidence for all learners.

Finally, a clear understanding of the subject matter is a necessary step in the assessment process. Without a clear understanding of the subject matter, determining important learning outcomes would be a difficult, if not impossible, task.

How is it to be measured?

One method of measuring student progress is through the use of a rubric. A rubric is a rule of procedure. "When the word is used in connection with assessment, a rubric is a scoring guide that differentiates...on an articulated scale..." (Jasmine, 1993. p.9). There are two kinds of rubrics, holistic and analytic. According to Jasmine (1993), a holistic rubric is used to measure the overall effect of a task and is qualitative in nature. An analytic rubric consists of score points assigned to various elements and is quantitative in nature. Determining clear and educationally sound learning outcomes is a major step in the assessment process. Well-constructed learning outcomes establish a strong foundation for prioritizing and creating a properly formulated rubric.

Setting criteria and standards of a rubric is a main component of authentic assessment. "Perhaps most important, scoring criteria make public what is being judged and, in many cases, the standards for acceptable performance. Thus, criteria communicate your goals and achievement standards" (Herman, Aschbacher, Winters, 1992, p.44).

Selecting the task to match the authentic assessment is also a crucial point in the assessment process. Aligning the assessment task with the intended outcomes should be done to ensure that the assessment can, in fact, measure the learning to take place. "When considering assessment tasks, your best choices are those you believe most closely target your instructional aims and allow your students to demonstrate their progress and capabilities" (Herman, Aschbacher, Winters, 1992, p.33). Herman, Aschbacher, Winters (1992) posed six questions to help educators choose good tasks:

- Does the task match specific instructional intentions?
- Does the task adequately represent the content and skills you expect students to attain?
- Does the task enable students to demonstrate their progress and capabilities?
- Does the assessment use authentic, real-world tasks?
- Does the task lend itself to an interdisciplinary approach?
- Can the task be structured to provide measures of several goals? (p.35-37)

Choosing an appropriate task must then be followed by describing the assessment task in a manner that is clear and documentable in order for others to replicate and/or interpret the finding. Finally, Herman, Aschbacher, Winters (1993) offer a set of criteria that help to ensure that the appropriate learning tasks lead to sound assessment. These criteria are:

- Do the tasks match the important outcome goals you have set for the students?
- Do they pose an enduring problem type, the type of problems and situations that students are likely to face repeatedly in school and their future lives?
- Are the tasks fair and free of bias?
- Will the tasks be credible to important constituencies?
- Will the tasks be meaningful and engaging to students so that they will be motivated to show their capabilities?
- Are the tasks instructionally related/teachable?
- Are the tasks feasible for implementation in your classroom or school in terms of space, equipment, time, costs, and so forth?. (p. 41-43)

How to interpret verbal & non-verbal messages or data.

The assessment process is a matter of the verification of student learning. In the authentic assessment process, students are engaged in authentic and meaningful tasks. According to Wiggins (1993), the assessment process is authentic when we directly examine student performance on worthy intellectual tasks (p. 3) therefore, the reliance on sound first-hand observation of both verbal and non-verbal learning situations is a vital component in authentic assessment. Teachers involved in authentic assessment need to develop strong observational skills. Harp (1991) discusses observation as a powerful tool for the evaluation of students as they are engaged in the performance of *real world* tasks (p. 75).

First-hand observation provides an understanding of both the activity and the context in which the activity is performed. It allows the observer to make more reliable inferences concerning the performance activity. Better understanding and more reliable inferences are a direct result of the observer's ability to concentrate on worthy intellectual tasks in order to evaluate the performance activity more clearly.

The ability to interpret verbal and non-verbal messages accurately, validly, and reliably through the observation of learning situations requires particularly careful analysis and judgment on the part of the observer. "The validity and reliability of qualitative data depend to a great extent on the methodological skill, sensitivity, and training of the evaluator. Systematic and rigorous observation involves far more than just being present and looking around" (Patton, 1987, p. 8). The value of observational data is developed through the observer's descriptive documentation of the setting, the activities, and meaning of what was observed.

Critical Viewing

The teacher has always been a critic to some extent, but are teachers critical viewers as well? According to James Brown (1991), "The critic, and the critical viewer, must be grounded in two essential areas of this act of critical judgment: the area of facts (what is informational data) and the area of norms or standards (what ought to be criteria)" (p. 24). Thus, teachers are critical viewers by nature, but perhaps not by systematic process.

The process of critically viewing performances involving human action has not been adequately addressed through research. Perhaps this is because no critical viewing model exists to guide teachers in systematically assessing their students. Traditionally, critical viewing has involved the interpretation of verbal and non-verbal information involving some form of media such as movies, photographs or television. As Ploghoft and Anderson (1982) stated, "individuals trained in critical viewing skills will be equipped with criteria for evaluating intention, motives, and audience response (students), for assigning value or worth to the message" (p. 5). This paper attempts to provide a critical viewing model for education by providing teachers with a systematic three phase process for the development of an authentic assessment instrument which includes a critical viewing component. However, before discussing the third phase that involves critical viewing for teacher/researchers, it is important to understand how and where critical viewing skills developed.

Critical reading skills evolved into critical viewing skills in order to better analyze electronically mediated messages. As John Long (1989) observed, "much of the groundwork for critical viewing was derived from work in critical reading. In critical reading, individuals learn procedures to extract and assimilate from the print media" (p. 12). Critical viewing follows a similar process but involves electronic media. As society and media became more sophisticated, the need to understand how information was interpreted through electronic media grew.

Several projects and studies were conducted to analyze and develop standard critical viewing skills for elementary, middle school, high school and adult students. The elementary project was conducted by the Southwest Educational Development Laboratory, WNET a public television station in New York published the middle school segment, the Far West Laboratory in San Francisco developed the high school study and Boston University's School of Public Communications developed the adult program. The project's goal was to assist individuals in monitoring their own viewing habits; in other words, to teach people to view television from a perspective other than that of the medium.

There have been many different sets of skills developed for various mediated situations and targeted at certain age levels. For example, the Southwest Educational Development Laboratory defined critical viewing skills as the ability to distinguish program elements, make judicious use of viewing time, understand the psychological implications of advertising, distinguish fact from fiction, recognize and appreciate differing views, understand content of dramatic presentation, understand style of dramatic presentation and understand the relationship between television and the printed word (Brown, 1991, p.96). Although a general standard of critical viewing skills is difficult to identify, the majority of projects and studies share the concept that people must not be passive consumers of information because they lose the ability to understand the world from varied perspectives. Adams & Hamm (1988) observed, "Intelligent consumers of video information need to be able to sort out the meaningful from the trivial" (p. 82). An increased level of critical awareness has the potential to move the viewer from passive information processing to active information processing. This is true of any viewing situation, be it mediated or live. In the age of information, how one views life can help or hinder understanding reality. Thus, critical viewing is more than understanding mediated messages. It is understanding all types of messages from mediated to live. As Adams & Hamm stated, "Effective viewing of real world images requires a critical sense for both information and shades of meaning" (1988, p. 82).

Critical Viewing in an Educational Setting

Critical viewing of student performance is the next step in the evolution of critical viewing skills. The general framework consists of "the principles of intervention, goal attainment, cultural understanding, and literacy" (Long, 1989, p. 13). Intervention involves understanding the process of perception and may be altered through self-regulatory skills. This is a major step because it is at this level that the viewer stops being a passive viewer and becomes an active viewer. The active viewer begins to understand how his/her own internal perceptions and biases are developed. Individuals bring a set of beliefs to every situation. Discovering how to separate one's own perception from the visual messages in a situation is the key to becoming a critical viewer. An example of this is a teacher using a rubric to assess a child's performance. In order to incorporate critical viewing into the assessment, the teacher must use intervention to understand how his/her internal perspectives may affect the assessment. For instance, if a teacher is tired or has had difficulty with a particular child in the past, a skewed perspective of the child's ability may occur. This skewed perspective may in turn alter the assessment process.

The next step in the process of becoming a critical viewer is goal attainment. Goal attainment involves monitoring and understanding one's own reasons for attending to the learning situation as well as recognizing the student's own (and possibly different) rationale for participation. In other words, the viewer and the student performing the learning activity each have a set of goals. These goals do not necessarily refer to learning activity goals but refer to the personal goals of the teacher and of the student at the time of assessment. The teacher may want the student to complete the activity in a certain way and the student may want to just get through the task. It is the responsibility of the critical viewer to understand his/her personal goals as well as the goals of the person being assessed. By accomplishing this, the critical viewer can ensure that the goals of the learning activity are mutually understood and that the evaluation of the students' performance is not adversely affected by a clash of personal goals.

The third step in the critical viewing process is cultural understanding. Cultural understanding is knowing where the learning situation exists within the social schema. It is the opposite of the intervention step because the viewer now focuses on external awareness of the perceptions and biases of the individuals being assessed. For example, students' race, religion, gender, etc. play a large role in their perception of any learning situation. The students' perceptions and biases will be likely to affect their performances and thus adversely alter the assessment unless the teacher/viewer incorporates cultural context into the assessment situation.

The final step in the critical viewing process is literacy. Literacy is understanding the overall grammar of the learning situation, such as body language or actions of the learner in the course of an activity (physical, behavioral, and/or cognitive). It is at this step in the process that the viewer can take all of the knowledge gained from the first three steps of the critical viewing process and actually interpret what is seen during the learning activity. For example, the body language, vocal tone and verbal usage of a diabetic child with low blood sugar will appear as a normal child behaving poorly. A trained and well-prepared teacher critically viewing the learning situation will assess the whole child within the learning context. A teacher passively viewing the situation might assess the child incorrectly by not being aware of perceptions and biases, personal and other goals, external awareness of others' perceptions and biases, and the literacy of how to communicate.

The four steps to critical viewing skills create skilled observers who are trained and prepared for authentic assessment. Critical viewing adds an important component to the authentic assessment process, filling in valuable contextual information about performance, thus creating a more valid and reliable assessment.

Pre-Assessment Focusing Session

A well-trained and prepared critical viewer recognizes the need for intense focus and concentration in the observation process. Prior to entering an observational situation for the purposes of assessment, a classroom teacher must set aside time to mentally prepare for the complex exercise of interpreting the verbal and non-verbal messages in a student's performance. This process is referred to in this paper as a *pre-assessment focusing session*. A pre-assessment focusing session utilizes the four steps of critical viewing and is intended to focus a teacher/researcher's critical viewing skills in order to filter out personal perceptions or biases that could be present during an assessment situation. This process involves little time commentment but such focused preparation is essential for effective critical viewing and assessment. Once a teacher/researcher becomes familar with the steps of critical viewing the pre-assessment focusing session should become an integral part of the assessment process.

Summary

What is taught, *how* it is taught, and *how* it is assessed are critical issues within the educational community. The three phases discussed in this paper integrate the major steps involved in the development of a sound authentic assessment instrument.

The first phase addresses the need to carefully formulate a clear understanding of *What is to be assessed?* This includes the identification of the purpose of the assessment, recognizing the uniqueness of the learners, and possessing a knowledge base in the relevant subject matter.

The second phase looks closely at *How is it to be measured?* Determining appropriate learning outcomes will drive the instructional and assessment processes, therefore the formulation of the learning outcomes and the criteria and standards that will be applied to them are critical components. This leads directly to the selection of a suitable assessment task. The assessment task is an essential component of authentic assessment and is not only important from the stand point of validation of student learning but is vital for the students themselves to understand the expectations of the learning task. Ralph Tyler (1949), father of modern evaluation, commented that without an understanding of what a learner is supposed to know or how it is to be expressed, makes determining whether or not learning has actually occurred very difficult.

The third phase describes *how to interpret verbal and non-verbal messages or data* in the observational process of authentic assessment Goodman stated, "teachers are constant kid watchers" (1986, p.41). As such, classroom teachers need to be trained and well-prepared observers of all activities throughout the school day. Teachers must remain focused and objective just as qualitative researchers in scientific fields do. Trained and well-prepared classroom teachers become more astute observers of the underlying meaning and social context of student behavior, thus creating the potential for improved quality of their findings and ultimately of their assessment procedures.

Since teacher preparation is essential for accurate interpretation of verbal and non-verbal messages, the inclusion of a brief pre-assessment focusing session prior to an observational assessment will positively impact the assessment process. This focusing session sharpens a teacher's concentration and heightens the teacher's awareness of personal interventions, goals, the cultural context, and literacy issues that may interfere with, contaminate or unfairly influence the assessment process.

The integration of the three phases process described in this paper into the authentic assessment process provides the classroom teacher with a systematic method of developing an effective assessment instrument. Processing information through the first, second and the third phases gives a classroom teacher a sense of confidence in the development of their own authentic assessment instrument as well as their observational skills.

As classroom teachers strengthen their observational skills and begin to recognize their roles as *teacher-researchers* involved in important qualitative educational research, hidden benefits are likely to be discovered. The impact of these hidden benefits will be seen on two levels. On one level, the classroom teacher will experience an increase in confidence and professionalism. On another level, there will be direct positive effect on daily instructional and social classroom activities. The significance of these powerful hidden benefits will, by their very nature, have a positive impact on teachers' creativity and on their overall effectiveness in the instructional and assessment process.

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Title:

Color Variations In Screen Text: Effects On Proofreading

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BACKGROUND

As the use of computers has become increasingly common in society, the number of people working with video display terminals has risen dramatically. The computer operator, possibly the weakest link in the computer's productivity, has been frequently overlooked by manufacturers and software developers. Human engineering and ergonomics are in a relatively primitive state compared with the physical sciences that created the equipment.

One important aspect of this interaction between the operator and the computer is the area of screen layout and design, and a question primary to good design is that of the color configuration of the screen text itself. Color has been identified as being an important design consideration (Dwyer, 1972), but variations in the configuration of color have received less conclusive research attention. Taylor and Murch (I986) considered both text and graphic displays when reviewmg the principles for effective color coding on video morntors. They caution that both background and text colors must be considered and that the relative degree of saturation is a critical factor. The concept of perceived brightness and saturation of color has been researched by a number of investigators with sometimes conflicting and contradictory results (Stanton, 1992; Lippert 1985; Wald, 1967). Joyner (I992) concluded that amber text on green was the most effective for reducing errors in document proofreading.

Research on the use of color in improving the usability of a screen display has also provided conflicting results. Kopala (I981) and Sidorsky (I982) found color to be a positive factor while Tullis (1981) and Christ & Teicher (1973) found color to impair performance. Joyner (1989) found keyboard error detection unaffected by color. Other researchers have investigated the effectiveness of variations in color contrast, again, with mixed results (Schnure, 1996; Edstrom, 1987; Gruning, 1985; Lalomia & Happ, 1987). Clearly, the often contradictory findings of these studies emphasize the need for more systematic investigation of the factor of screen text color configuration, particularly with regard to the characteristics of the particular user and user's experience with a video display terminal.

This study was conducted to determine the effect of the color configuration of a video display terminal (VDT) on the operator's ability to detect typographical effors in keyboarded copy. Two primary research questions were addressed: (1) Is there an interaction between keyboarding experience and the color configuration of the VDT in terms of proofreading ability, and (2) Is there a relationship between the color configuration of the VDT and the location of undetected keyboarded errors on the screen.

METHODS AND PROCEDURES

The research sample in the study consisted of 97 undergraduate students enrolled in a college of business at a Pennsylvana university. To assure an accurate representation of varied ability levels and ages, participants were drawn from two regional campuses as well as the main campus. Subjects were subsequently divided into 3 ability level groups--beginning, intermediate, and advanced--based upon their reported keyboarding experience.

The design employed in this study was a 3 x 4 repeated measures design that compared three ability levels across four color configurations: (1) white text on blue background, (2) blue text on white background, (3) green text on amber background, and (4) amber text on green background. Each treatment condition reflected commonly used color configurations used in popular word processing packages.

The materials developed for the study consisted of four business documents containing similar numbers of typographical and layout errors, equally distributed in all four quadrants of the screen. The documents were created using a popular word processing package and were drawn from a departmental exemption examination used in a keyboarding and document formatting class.

Each subject was presented with the four documents in a controlled laboratory environment and was instructed to locate and mark the errors using the overstrike feature of the word processing package. Ten minutes were provided for work on each document. All documents were rotated through each treatment at each campus location to ensure that every subject received all treatment conditions.

FINDINGS AND RESULTS

Using the tabulated data, an analysis of variance for repeated measures was conducted on the treatments by experience levels to test the first research question: Is there an interaction between keyboarding experience and color configuration of the video display terminal in terms of proofreading ability? The results of that analysis revealed a significant interaction (F=3.504; p=.0023). See Table 1.

Table 1.
ANALYSIS OF VARIANCE ON TREATMENTS BY EXERIENCE LEVELS

Source	df	Sum of Squares	Mean Square	F Value	p Value
Experience Level (A)	2	14.117	7.058	3.761	.0268
Color Configuration (B)	3	8.894	2.965	1.094	.3518
Experience x Color (AB)	6	56.951	9.492	3.504	.0023
Error	282	763.904	2.709		

The means and standard deviations for all color confgurations and experience levels is presented in table 2.

Table 2
TABLE OF MEANS AND STANDARD DEVIATIONS
FOR COLOR CONFIGURATION BY EXPERIENCE LEVEL

Color Configuration	WhiteText/Blue Background		Blue Text/ White Background	
	Mean	SD	Mean	S.D.
Advanced Level N=45	4.111	1.668	4.444	1.531
Intermediate Level N=32	3.406	1.563	3.156	1.439
Beginning Level N=20	3.65	1.461	2.221	2.221
Totals N=97	3.784	1.609	3.773	1.765

Table 2 (Continued)

Color Configuation	Green Text/ Amber Background		Amber Text/ Green Background		Totals		
	Mean	S.D.	Mean	S.D.	N	Mean	S.D.
Advanced Level N=45	3.689	1.635	3.022	1.215	180	3.817	1.601
Intermediate Level N=32	3.469	1.646	3.5	1.606	128	3.383	1.553
Beginning Level N=20	3.3	1.593	4.25	1.552	80	3.612	1.747
Totals N=97	3.536	1.621	3.433	1.485	388	3.433	1.63

Pair-wise comparisons of all means via the Fisher Protected Least Significant Differences Test (PLSD) indicated that for advanced level subjects either white text or blue text was significantly better than any green or amber formats. In contrast, the multiple comparison tests indicated that beginning level subjects performed significantly better with the amber text on green. Significant comparisons are presented in Table 3.

Table 3.
SIGNIFICANT POST-HOC COMPARISONS OF TREATMENTS BY LEVELS OF EXPERIENCE
(p <.05)

COMPARISON	MEAN DIFFERENCE	FISHER PLSD	DECISION
Adv White/Blue vs Adv Amber/Green	1.089	.656	Adv White/Blue > Adv Amber/Green
Adv White/Blue vs Int Blue/White	.955	.719	Adv White/Blue > Int Blue/White
Adv White/Blue vs Beg Blue/White	.861	.836	Adv White/Blue > Beg Blue/White
Adv Blue/White vs Adv Green/Amber	.756	.656	Adv Blue/White > Adv Green/Amber
Adv Blue/White vs Adv Amber/Green	1.422	.656	Adv Blue/White > Adv Amber/Green
Adv Blue/White vs Int White/Blue	1.038	.719	Adv Blue/White > Int White/Blue
Adv Blue/White vs Int Blue/White	1.288	.719	Adv Blue/White > Int Blue/White
Adv Blue/White vs Int Green/Amber	.976	.719	Adv Blue/White > Int Green/Amber
Adv Blue/White vs Int Amber/Green	.944	.719	Adv Blue/White > Int Amber/Green
Adv Blue/White vs Beg Blue/White	1.194	.836	Adv Blue/White > Beg Blue/White
Adv Blue/White vs Beg Green/Amber	1.144	.836	Adv Blue/White > Beg Green/Amber
Adv Green/Amber vs Adv Amber/Green	.667	.656	Adv Green/Amber > Adv Amber/Green
Adv Amber/Green vs Beg Amber/Green	1.228	.836	Adv Amber/Green < Beg Amber/Green
Int Blue/White vs Beg Amber/Green	1.094	.886	Int Blue/White < Beg Amber/Green
Beg White/Blue vs Beg Amber/Green	1.000	.983	Beg White/Blue < Beg Amber/Green

Since a significant interaction was found, research queston 1 is answered in the affimative. A significant interaction does exist between keyboarding experience level and the color configuration of the video display terminal in terms of proofreading ability. The interaction data is displayed graphically in Figure 1.

Analysis of data strongly suggest that experienced keyboarders will demonstrate greater success in proofreading when working with either blue or white text. The findings of several other researchers have indicated that dark spectrum colors make better background choices and this study supports that conclusion with regard to the use of white text on a blue background with experienced keyboarders. On the other hand, research that suggests that amber text on green is superior may only apply to beginning level or inexperienced users.

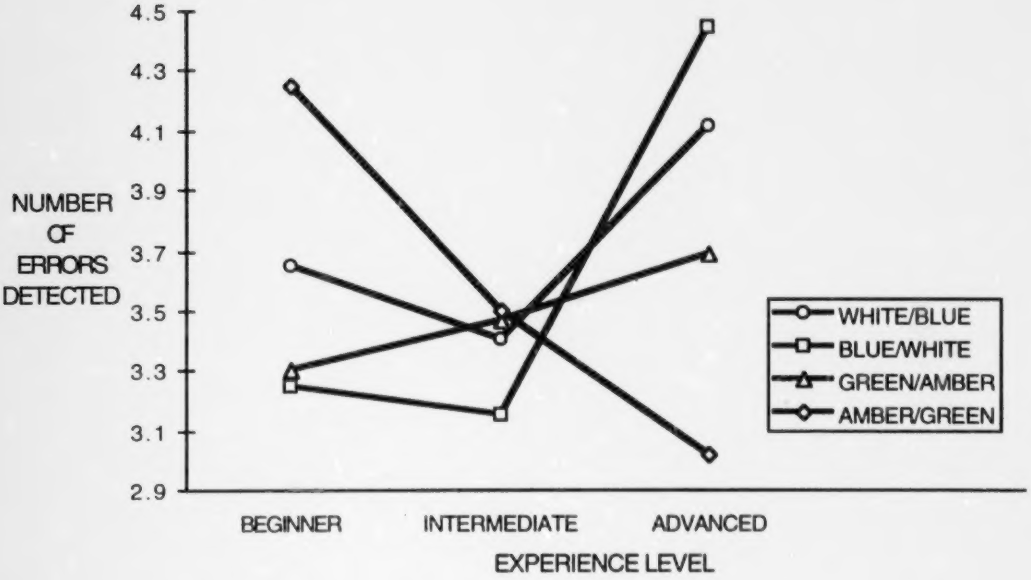

Fig 1.

Interaction Data

Analysis of data related to research question 2: Is there a relationship between the color configuration of the video display and the location of undetected keyboarded errors on the screen, was addressed via analysis of variance of the mean numbers of undetected effors in each of the four screen quadrants. An analysis of Quadrant 1 data did not produce a significant effect (F=1.349, p=.2587). Similarly, analysis of Quadrant 2 data did not produce a significant effect (F=1.152, p=.3286).

The analysis of Quadrant 3 data did reveal a significant treatment effect (F = 3.433,p =.0175). Further analysis of all possible pair-wise comparisons via the Fisher Protected Least Significant Difference Test (PLSD) was conducted. Significant comparisons are presented in Table 4.

Table 4.
SIGNIFICANT POST-HOC COMPARISONS OF TREATMENTS
ON QUADRANT 3 ERROR DATA
($p < .05$)

COMPARISON	MEAN DIFFERENCE	FISHER PLSD	DECISION
Green/Amber vs White/Blue	.206	.167	Green/Amber > White/Blue
Blue/White vs White/Blue	.247	.167	Blue/White > White/Blue

Significantly fewer undetected errors occurred in Quadrant 3 when the color configuration was White/Blue rather than Green/Amber or Blue/White.

An analysis of the data related to quadrant 4 produced a significant treatment effect (F=7.343 p=.0001). Further analysis of all possible pair-wise comparisons via the Fisher Protected Least Significant Difference Test (PLSD) was conducted. Significant comparisons are presented in Table 5.

Table 5.
SIGNIFICANT POST-HOC COMPARISONS OF TREATMENTS
ON QUADRANT 4 ERROR DATA
($p <.05$)

COMPARISON	MEAN DIFFERENCE	FISHER PLSD	DECISION
White/Blue vs Blue/White	.227	.151	White/Blue < Blue/White
White/Blue vs Green/Amber	.278	.151	White/Blue < Green/Amber
Blue/White vs Amber/Green	.216	.151	Blue/White > Amber/Green
Green/Amber vs Amber/Green	.268	.151	Green/Amber>Amber/Green

These comparisons indicated that both White/Blue and Amber/Green formats were significantly more effective in reducing the number of undetected errors in the fourth quadrant. Of particular interest is the fact that both of these formats consisted of light text on a dark background, a fact which may have made the text more distinct and consequently more effective.

The quadrant data also suggests that the greatest number of undetected errors occured in the third and fourth (lower) quadrants of the screen. This may be explained by eye movement studies which demonstrate that the least time is spent viewing this area.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations that follow are based on the findings of this study and may serve as guidelines for future research.

1. Since there is a significant difference in the proofreading abilities of keyboarders possessing advanced levels of keyboarding experience when different color configurations are used, the color configuration of the video display terminal is critical. The most effective color configuration for advanced ability keyboarders appears to be blue text on a white background. Beginning level keyboarders seem to work most effectively when using amber text on a green background. No particular screen configuration seems to assist keyboarders with intermediate level skills.

2. The proofreading ability of the keyboarder increases in proportion to his or her experience level. Individuals with the most keyboarding experience are better proofreaders.

3. The location of the error within a particular quadrant of the screen will determine the relative probability with which the error is detected by the operator. The results indicate that more errors go undetected in the lower half of the screen (Quadrants 3 & 4) than in the upper half of the screen (Quadrants I & 2). These results are in agreement with findings of other researchers who have shown that the eye moves from the upper left corner of the display and scans from left to right, starting at the top. This visual scanning follows the same general ordered pattern as that used in reading printed text. Thus the results have direct implications for the instructor as proofreading techniques are taught

4. White/Blue and Amber/Green configurations appear to be most effective in helping users detect errors in the lower two quadrants. These both represent light text on dark backgrounds which may make the text more distinct. It would appear that particular attention should be given to making text in these quadrants as distinctive as possible to compensate for this apparent disparity in color effectiveness.

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Title:

Mistaking identities: Challenging representations of language, gender, and race in high tech television programs

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> ReBoot's scripts are deftly written to be easily understood by children, with a wink and a nod to the adult viewers. The citizens of Mainframe speak in a high tech dialect that incorporates computer terms that have crept into the everyday language of the automated age. Bob complains when a task is not his 'function'. Enzo is encouraged to 'cut and paste' the truth. When Enzo gets discouraged, Dot counsels him not to 'quit file' so easily.
>
> (Excerpt form [ReBoot] Press Kit - Alliance Communications and BLT Productions)

> ...we need to look not just at work that collectivities collaboratively do to construct gendered worlds but also look at the work that language does to limit, shape, make possible, one kind of world or another. ...The individual subject is understood at one and the same time to be constituted through social structures and through language, and becomes a speaking subject, one who can continue to speak/write into existence those same structures through those same discourses. But as a speaking subject, they can invent, invert and break old structures and patterns and discourses and thus speak/write into existence other ways of being.
>
> (Bronwyn Davies)

Introduction

The genesis of this paper developed through an awareness of the growing number of television programs that feature information technologies like computers as significant narrative devices. These devices include the use of computer based technologies as environments in which characters interact (e.g. virtual worlds) and the use of computers as tools that characters utilize to confront conflict (e.g. computers as problem solving tools). Characters in these programs are often themselves part human, part machine; cyborgs, fused and bonded with technology. These television programs include science fiction shows (e.g. Star Trek: The Next Generation, Star Trek: Deep Space Nine, Star Trek: Explorer, Space: Above and Beyond, Babylon 5, Sea Quest, Dangerous Games, etc.) commercials (e.g. IBM, Microsoft, Intel, Apple, etc.) and children's shows (e.g. Power Rangers, ReBoot, Johnny Quest, VR Troopers, Reality Check, etc.). In addition to their use as narrative devices in these programs, computers are increasingly made reference to and talked about on numerous prime time situation comedies (e.g. Home Improvement). Within the state-of-the-art worlds of television programs using high tech innovations are embedded representations, including the use of language, which inscribe simplified, compartmentalized and encased conceptions of race, gender, and power. Characters in these programs engage in a pseudo-language appropriated from computers and science, where a specialized vocabulary is part of the "natural" lexicon.

As a student and teacher of educational technology watching these programs based on themes derived from high tech innovations, I am concerned with how young viewers through the constructed character identities in these programs transform difference in relation to the technical language and encased representations of gender, race, and power to a potentially alienating otherness in young people. A Saturday morning children's cartoon like "ReBoot" appears in 40 countries throughout the world. How do young people who do not possess the same literacies and competencies as these television characters apparently possess, interpret this jargonized language and imagery? Will some young people confuse their differences with deficiency? How will this structure their relationships with technology in using the computer as a tool for learning? How may young people be relegated to low tech ghettos of impoverished knowledges about technology, computers, and computer culture in the way these shows through their imagery, language and narrative structure help construct these ghettos and position the low tech viewer in relation to the cultures advanced in these shows?

These questions evolved while watching programs like "Star Trek: Voyager" and "ReBoot" with the four young people with which I live [ages 9 (male), 12 (female), 13 (male), and 15 (female)]. Even though these young people posses a working knowledge of computers and have access to computers both at school and at home, aspects of these shows including stereotypical descriptions of race and gender do not resonate within their experience. They see Western stereotypical representations of race and they do not match their experiences with their friends of color - they're experiences are more idiosyncratic and unique compared to the offered stereotypes. They view the tight fitting uniforms that the slim female characters in these shows often wear and the girls do not see an ideal of femaleness, instead they often see unrealistic and undesirable conceptions of physical beauty.

The question kept surfacing, "In what ways do 'different' children (i.e. young people with different social positioning and literacies then those depicted by the characters in these programs) attach meanings to the words and metaphors,

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characters and narratives of these TV programs and how do the meanings they attach impact their relationship with themselves and the societies and communities in which they must negotiate their lives?"

Examining the role of popular culture in framing issues of race, gender, and agency including the power of television with its capacities for representation and construction of meaning, is central to understanding how the mass media inform, structure, and constrain the daily lives of many young people in postmodern societies(Agger, 1992). Through portrayals of postmodern life, television programs teach specific ways of knowing and being about race, culture, and gender (Giroux, 1989; Cortés, 1995). In discussing ways that high tech shows may position themselves in relation to young viewers, I would like to focus on the processes with which these shows simplify, compartmentalize, compress, and encase language, personal agency and identity. I will frame this analysis through an examination of an episode of a popular Saturday morning cartoon, "ReBoot".

As Bronwyn Davies (1993) observes language and discourse play a constitutive role in the construction of gender. The languages with which young people engage themselves, others, and television programs have consequences on the ways they situate their identities of race and gender, as well as personal and social agency. Language limits and shapes, making one world in which 'difference' is viewed as 'other' more possible than another where 'difference' is viewed as part of a larger collective. Young people watching television and interpreting language spoken by television characters are forms of discourse, albeit largely unidirectional discourses from program to viewer(s). The types of languages which are spoken on television programs based on themes derived from high tech innovations are by and large unnegotiated: young people must construct meanings within themselves or perhaps between themselves and the others they may be watching with without an exchange with the characters. They cannot say, "What did you mean that you 'downloaded files' or 'How are you using the word 'bitmap'?" Young television viewers cannot interact with characters in a cartoon who use a great deal of computer terminology or directly challenge their use of language or portrayals of gender or racial stereotypes. The discourses do not extend directly back to the media. This hermetic encasement of specialized language associated with computers has the potential to alienate young people and separate them from their sense of personal agency. This separation positions the young viewer as an "other" in relation to dominant forms of language about computers and shifts the responsibility to the viewer to understand and make sense of what is seen and heard. The 'pedagogy', if you will, of television is similar to the dominant model of education which positions students as passive receptacles of information.

Related to the way that television encases language is the way that language has developed around computers in which a similar reification of meaning exists. Through increasing interaction with computers at home, school, and work computer terminology has crept into the popular culture and is often used as metaphors to describe aspects of daily lives. A glance at the comic section of any newspaper will reveal numerous references to computer culture. Computers have served as the dominant metaphor of the human mind for the cognitive sciences for decades. In discussing the growing infusion of computer terminology as a form of metaphor into language Sardello (1985) writes, "Computer terminology is certainly not a living language, but rather the enslaving language of turning every form of speech into an object to be manipulated by the totalitarian grammar of computational logic".

Living in western postmodern societies engages young people on multiple and fluid levels of social interactions where experience is fractured though an ever-present interaction with mass media including television, film, radio, and computers. By simplifying and compartmentalizing complex issues and relationships, television tries to neatly encase the unknowable and constantly changing through a process of fixing and rendering static and objectified that which is always changing. An example of these processes in television is the always neatly drawn line between good/evil and right/wrong in many programs. This simplified encasement of meaning through dualism goes counter to the complexities of western postmodern life. Developing a practice to challenge the ways that these programs manage and control the potential for 'difference' in multivalent and ambivalent characters, meanings, and interpretations becomes an important task and challenge for educators. By challenging dominant cultures' needs for legitimization, consumerism, and productivism, the literature surrounding critical pedagogy which began with the writings of Paulo Friere (1970) has provided an educational framework with which to address issues arising from critical cultural studies. Critical pedagogy provides the point of praxis, the meeting of theory and practice through the political.

Critical Pedagogy

Ideas of critical and emancipatory pedagogy provide a framework with which to form strategies of practices to work with young people to reinterpret the potentially alienating messages of the programs discussed. By framing pedagogy as a cultural practice of cultural production, critical pedagogy addresses the relationships between language, power, knowledge and individual agency and views learning as part of the process of social change itself (Kanpol, 1994). Always viewing teaching as a political act, critical pedagogy strives to understand how power works within particular historical, social, and cultural contexts in order to engage and, when necessary change such contexts. Henry Giroux (1994) writes:

> By refuting the objectivity of knowledge and asserting the partiality of all forms of pedagogical authority, critical pedagogy initiates an inquiry into the relationship between the form and content of various pedagogical sites and the authority they legitimate in securing particular cultural practices.

If one frames viewing television as an act of cultural learning then a practice influenced by critical pedagogy may help challenge static representations of language, gender, race, and personal agency. Critical pedagogy opens new discourses with popular culture texts. For example, while discussing the technical language used in a particular television show with a young person a teacher may ask her or him questions about dominant forms of language, consumerism, and their relationship to these dominant discourses. Questions about the young person's conceptions of what types of people might better understand this technical language may prove productive? As Apple (1990) challenges teachers must enable students to "..inquire as to *why* a particular collectivity exists, *how* it is maintained and *who* benefits from it." Questions within a critical framework help the young person to side-step being positioned against these dominant discourses as 'other' and powerless, and help to redefine notions of agency and power.

Theorists working within this framework often draw upon poststructural ideas to gain entrance into the power struggles of representations of race and gender in popular cultures. Poststructural theory defies universalizing meanings and provides pedagogical theorists a means to break notions of totalizing and totalizable power and control. In poststructuralism power is seen as dispersed, as networked and horizontal rather than vertical and concentrated. Poststructuralism rewrites notions of power (away from the dualisms of powerful/powerless; dominant/subordinate) and toward notions of lines and vectors of power that can be concentrated within nodes of institutional practice, and within particular historical contexts and situations. Poststructuralism assert that language is an important mode of representation that constitutes what counts as reality. In this sense students can become what Henry Giroux calls "border intellectuals" - crossing the boundaries of dominant power structures including the politics of representation that television structures.

Influenced by poststructural ideas a teacher thinks of ways of helping young people rewrite the potentially encasing ideas of gender, race, and personal agency of television programs. This work can happen in many forms including discussion, writing, and the creation of media including music, photography, and video (Paley, 1995). Important to cultural and pedagogical theorists is the politicization of culture. These ideas often considered liberal and even radical are ignored by many theorists in education who refuse to see school as a site of political struggle for identity. Yet as Toni Morrison (1993) notes, "Excising the political from the life of the mind is a sacrifice that has proven costly."

Some who have examined the literature on critical pedagogy contend that these theories are highly abstract and may not necessarily sustain the daily practice of the education its supporters advocate (Ellsworth, 1989). Despite extensive literature in this area, scholars rarely in their writings locate their theoretical constructs within actual localized practice. If one is to believe the arguments of postructuralism, that meaning is negotiated and constructed by the individual within a social context , then it is important for us as educators to find local and personal venues to realize critical theories. This should not be interpreted as a pedagogy that leads to isolated individualism but to a pedagogy that helps the individual situate their place in a living history. Michael Shapiro (1995) writes the significance of emphasizing individual lives:

> ...is not its refocusing from collectivities to individuals but its identification of the plurality of consequences, registered in different lives, that become available when descriptions of the intersections of different flows of activities are allowed to displace the official language of the order.

Theory only exists in the way that it is acted upon. A variety of educators drawing upon different aspects of critical pedagogy have found ways of deconstructing some of the hegemonic influences within postmodern western societies including the struggles to situate multicultural activism in the University (Ellsworth, 1989) politicize power in teacher education (Giroux, 1994), bring critical readings of mass media into the high school classroom (Fehlmand, 1992) and find new ways of re-reading and re-writing 'history' through testimony (Felman & Laub, 1992).

If one views education as a social and political process and wishes to support the individual student's construction of meaning then it becomes necessary to find local venues of practice to address power and agency -to irritate the taken for granted simplification, compartmentalization and rigid encasement of representations of power, race, and gender. Critical pedagogy supported by poststructural ideas provides ways of finding the "interpretive breaks"; the points at which we get close enough to see the cracks in an ideology, power structure, or representation by making visible the invisible walls that maintain inequities. These walls could be a subtext or the words or actions that go unspoken, intentionally or not.

I turn now to a specific examination of a cartoon to highlight some of the ideas that I have advanced about high tech television shows and their capacity to simplify, compartmentalize, compress, and encase language, gender, race, personal agency and identity.

"ReBoot"

"ReBoot" is an ABC Saturday morning cartoon that airs in 40 countries in North and South America, South Africa, and western Europe. The show is translated from English into several languages including Spanish, French, and German. "ReBoot" takes place on an "Island" called "Mainframe" within a computerized world . All characters in ReBoot are computer programs called "Sprites". I chose to analyze "ReBoot" for this paper because of its use of computers as the axis around which the entire narrative rotates. Characters in the cartoon use language that is specific to computers in the real world to describe more universal human actions and characteristics (i.e. improvements in a character may be described as an "upgrade"). There are many parallels in language that a young person who uses a computer regularly may make with her or his own life. Yet there are many who do not possess this type of 'literacy'. One wonders of the meanings that will be constructed by a young person who feels alienated by such language.

There are five main characters in the cartoon. "Bob" is a 'Defender,' a guardian program from the advanced civilization of the Super Computer. Using Glitch, a multi-functional computerized protection device he wears on his wrist, Bob represents the young male warrior ready to protect Mainframe from any electronic threat. "Dot Matrix" is the shows female character and as the shows press release states is "an attractive entrepreneur". Dot's primary business venture is as owner of "Dot's diner". "Enzo", Dot's adolescent brother, serves as the character young viewers may most associate with - often too young to be in the action, he must wait on the sidelines while Bob and Dot do the work of adults - saving Mainframe. Enzo is portrayed as the 'typical' *American* adolescent boy with crooked baseball cap, skateboard, and dog, "Frisket". Positioned against this representation of boyness how would a young viewer in South America construct his or her conception of 'boyness' or 'girlness'? One never hears of parents nor sees Dot and Enzo's parents in the show. Through their speaking of standard American English, these characters display typical European characteristics of whiteness. "Phong", a cyborg character , half machinelike, half human, is the only identifiable character of color - golden colored and displaying the west's stereotypical images often associated with mature Asian men including goatee and a steady stream of Confucian wisdom. Phong serves as Mainframes spiritual mentor and the wise teacher of Bob, Dot and Enzo.

"Megabyte", a computer virus programmed to always grow and seek more power, is the story's darkly colored villain. During most episodes he aspires to increase his foothold in Mainframe which includes controlling about a third of the city. But, of course, he always fails and is made to look foolish in the process - his greed for power blinding. I wonder if Megabyte displays in this television program what Morrison (1992) calls in American literary tradition the "choked representation of an Africanist presence." Hexadecimal portrayed as a female is the shows other primary villain, a computer virus written to create chaos not seek power. Her face never moves when she speaks instead she puts on a series of masks to portray her mood or display a feeling she is trying to convey. Like Dot, Hexadecimal's hourglass figure conforms to the western stereotype of an attractive women.

At some point during each episode a purple gaseous cube descends from the sky and covers a sector of Mainframe. This is a game being loaded by the "user" the operator of the computer in which Mainframe is located. No one is certain of the "user's" identity, they only know her or him as the entity that tests the Sprite's (usually Bob, Dot, and Enzo) abilities to fight and win through physical strength and technical ability. The games are often "Dungeons and Dragons" styles games which are generally violent role playing games, mostly played in real life by adolescent boys. These games often include medieval contexts inhabited by wizards, fighters, thieves, and damsels in distress. Games also take the form of professional basketball games, wars, and car races. How will young viewers who are not familiar with the conventions of these games and scenarios map their own experience onto their viewing of ReBoot? When the sprites enter a game they must "ReBoot" : a process where they are assigned a "character" which defines their skills and weapons in the game. Passing through a series of levels, the defenders must win each game against the "user" or else the sector will go 'offline' turning each of the sprites in that sector into "Nulls" energy eating slugs that live in the lower levels of Mainframe.

In addition to the main characters is a sub population called "Binoms" who are more machinelike and look more like children's toys. They are generally shaped in the form of 1's and 0's. These characters are unidimensional and possess stereotypical personalities (e.g. a television with hands that is the "typical" French waiter, complete with mustache, exaggerated accent, and towel over the arm). Binoms passively populate Mainframe as it's proletariat - workers who do word processing, graphics and manipulate numbers, giving the main characters a populated context in which to act.

The episode examined for this paper is entitled "Identity Crisis", a two part story in which Dot tries to free a section (Sector) of Mainframe under Megabyte's control by importing the PID (personal identification numbers) of every Binom in the sector into a computer. These PID number are important because an individual, including a Defender, without one falls under the computer-based control of Megabyte. A PID is equivalent to personal freedom. Importing these numbers into a computer allows Phong to convert the sector into an Energy Park, a haven free from the dominating control of Megabyte. They must give up their only source of personal freedom to obtain the greater freedom of their community. In the episode after an emotional plea from Dot, the Binoms, rather passively give up their PIDs.

Notions of "revolution" are seen as mass, largely passive efforts carried out by a few vanguard leaders and not decentered individual (situated) actions. Through this vision, masses of undifferentiated binoms give up what makes them individual for 'freedom', an interesting metaphor for passive reception of mass culture. Agency is handed over to the few and powerful protectors of freedom. In "ReBoot" freedom means not under the control of the malevolent Megabyte

In this episode when it comes time to give up the PID numbers and all the Binoms begin to release theirs codes en masse there is a medium shot of a Binom family. The father in the family not only releases his own PID but the PID of the mother and the baby without getting their consent. Agency is usurped from the female and child by the father.

Dot, with her distorted Barbiesque physique, is the mastermind of this "sector conversion". It is through her careful planning, using a computer, that this grand event is possible. She prepares for her final meeting with the Binoms to collect their PIDs by changing from her tight fitting space-age pantsuit to a blue tight fitting business suit with black and white top, gold accessories, and a short black miniskirt. The outfit is completed with a pair of round black eyeglasses that she never wears in the series until this point. What do the glasses signify? That she knows better, but needs to reinforce this with the Binoms.

The creators of the show assume the viewers posses a tremendous amount of technical language frequently using computer words as everyday parts of language (See Table 1).

Table 1
Examples of technical terminology used in ReBoot

glitch	nullify	bug	alphanumeric	sprite
modemed	floating point	bitmap	8-bit	overwrite
low density	dot matrix	backspace	wait state	encryption
hidden file	COMMAND.COM	algorithm	unformat	downloading

What kinds of knowledge and skills must one have in order to have agency in Mainframe? It is clear from the success of sprites like Bob, Dot, and Enzo that one must be extremely computer literate as well as knowing how to fight. Physical dexterity and strength are valued and crucial to win a game and defeat the plots of Megabyte and Hexadeciamal .

Conclusion

There is not one way to read media. Any single, particular strategy of interpretation leaves out other ways of seeing. Whenever an interpretation is imposed on a perspective, alternative interpretations are repressed. Because no reading is innocent, the questions that go unposed about a text and what it means are as important as the questions that are asked. Learning is always situated and knowledge is always incomplete. As Ellsworth and Miller (1996) write:

> ...constructing and disrupting fixed meanings of difference is profoundly situational, and often tedious. It also is personal and social at the same time, risky, never predictable, and requires imagination and courage of the intellect as well as of the heart.

An idea, theory, power structure only exists in the way that it is acted upon not on the way that it is theorized about. Ultimately what is the good of situating the analysis of the "ReBoot" episode within critical pedagogy? There can be advantages to illuminating what goes unspoken in a piece of media, but for what purpose and for whom? Without praxis the re-creation of knowledge is incomplete.

For my part I can situate my analysis with the four young people with whom I live. I can ask them questions about their understanding of how language is used to construct meanings of race, gender, and agency and frame issues like how a female character displays stereotypical characteristics of femaleness through her actions. I have done this and often am met with confusion, yet creating confusion can open new ways of seeing. Together we have tried to re-construct meanings about various representations in "ReBoot". For example, I have asked them other ways that a character could confront conflict instead of using a particular technology. Discussions of negotiation and compromise have developed from this question as well as the problematic nature of the conflicts themselves (i.e. what is presented as important enough to engage the characters).

I can also challenge the teachers that I work with while teaching them video production to find ways in their own practice with students to rupture the inscriptions of identity presented by television and other mass media. These challenges will be highly idiosyncratic and unique to each teacher as will the way that each teacher responds to these challenges. Through video production, teachers, together with their students, can take stereotypes and encased representations of language, race, and gender and turn them back on themselves to rupture meanings and make room for new representations.

Ultimately what becomes clear is that one cannot proscribe this kind of cultural work - it is important to situate action within a specific community at a specific time. Regardless of whether representations are accepted passively or actively challenged, meanings will always be assigned to representations.

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Title:

E-mail Dialogue Journaling In an ESL Reading and Writing Classroom

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Abstract. This case study involved designing an electronic-based environment to explore the effectiveness of electronic mail (e-mail) as a writing tool for dialogue journaling. The setting for this study was in an intermediate level reading and writing class in the American English Institute Program on the campus of a large public university. Over a period of nine weeks, six random assigned English as a second language (ESL) students in the class wrote dialogue journals to their instructor using e-mail while the rest of the students in the class wrote dialogue journals to the instructor using paper and pencil. The issues investigated were: What were the students' attitudes toward dialogue journal writing via e-mail? What was the instructor's perception regarding e-mail dialogue journal writing? What problems occurred in the process of using e-mail as a tool for doing dialogue journal writing? In what ways, were e-mail journals different from paper journals? The findings of the study show that a variety of factors combined to exert an influence on the participants' attitudes towards e-mail. Limited knowledge about e-mail system prevented some students from taking a full advantage of e-mail as a unique communication tool. Comparison of e-mail journals and paper journals reveals that e-mail created a different writing mode than that of paper and pencil.

Literature Review

A dialogue journal is a daily written communication between two persons. In the classroom setting, the teacher and the student are the two partners involved in this written conversation. Each day, the student puts an entry into a bound notebook and hands in the notebook to the teacher. Students are not assigned a topic to write about. They can write about anything of personal interest and concern. Instead of grading or correcting the student's writings, the teacher writes an individual response to the student's entry. The next day, the teacher gives the notebook back to the student so that the interchange can continue. The written exchange can develop into a year-long daily conversation between the teacher and the student.

Since its first discovery as a classroom practice in 1979, dialogue journaling has been widely used in writing classrooms of English as a second language (ESL) to help students develop their writing skills (Jones, 1988). Peyton and Seyoum (1989) pointed out that dialogue journaling "held promise as a way to promote the writing development of limited English proficient students" (p. 310). Research shows that dialogue journaling is an effective way to help improve ESL student writing (Blanton, 1987; Gross, 1990; Gunkel, 1991; Gutstein, 1983; Reyes, 1991; Peyton, Staton, Richardson & Wolfram, 1990; Rinvolucri, 1983; Spack & Sadow, 1983; Staton, 1988; Staton, Shuy, & Kreeft, 1982; Steer, 1988; Urzua, 1987; Venditti & Bahruth, 1986).

To date, the communication medium used for dialogue journaling has been paper and pencil. The advent of widely available computers and telecommunications has created opportunities to take dialogue journal writing one step further through use of e-mail.

E-mail is a unique communication medium. "It differs from any other communication in time, space, speed, ease of use, fun, audience, and opportunity for feedback "(Kiesler, 1984; p. 1127). As a written communication medium, e-mail not only allows the writer to interact with the text via the computer, but also makes it possible and easy for writers to interact with each other via the computer. E-mail enhances the communication between writers by transferring their writings to each other almost spontaneously. Equipped with word processing capabilities, e-mail smoothes the writing process of the writer. Thus, the computer becomes "a communication channel as well as a writing tool" (Daiute, 1985, p. xiv).

E-mail has been reported as an effective communication medium in a variety of educational settings. Surveys conducted across campuses in the United States reveal that teachers and students use e-mail as a communication tool to fulfill their personal needs. E-mail is used for exchanging information, discussing opinions, and socializing with people (Grabowski, 1990; Rice & Case, 1983). A survey by Schaefermeyer and Sewell (1988, p. 119) identified the advantages of e-mail as "speed, " "convenience, " "time-saving, " and "asynchronicity." Grabowski (1990, p. 280) identified the reasons for using e-mail as : "no time/place limits," "easy access," "knowledge of computers," "ease of use," "convenience," and to "try new things." These surveys indicate that e-mail is perceived by teachers and students as an accepted and valuable tool for personal communication.

E-mail communication is sometimes added to the regular classroom in the hope of increasing the interaction between teachers and students, and thus improving the quality of the learning environment. Studies report that students demonstrate an overwhelming acceptance of e-mail as a supplement to traditional modes of instructor-student interaction (Downing, Schooley, Matz, Nelson & Martinez, 1988; D'Souza, 1991; Hartman et al, 1991; Kinkead, 1987). Students described e-mail as "quick, convenient, and fun" (Kinkead, 1987, p. 338). The teachers interacted more frequently with their students using e-mail than they did in face-to-face or paper communication (Hartman et al, 1991). Students asked more challenging and more thoughtful questions, and the instructor's responses to these questions were often of higher quality than those they provided in face-to-face interaction (Downing, Schooley, Matz, Nelson & Matinez, 1988). The quality of instruction and student test scores improved because of the increased interaction between instructors and students (D'Souza, 1991).

E-mail expands the communication circles of the learner beyond the boundaries of the classroom and the campus. The learner is provided access to global communication and empowered in the learning process. Jenkinson (1992) reported a study on e-mail communication between a university professor and 20 students (fourth through seventh graders). The students sent their stories to the professor. The professor critiqued their stories via a home computer and sent suggestions back to the students. Most of the students revised their writings following the professor's suggestions.

E-mail links students together from different cultures. The Intercultural Learning Network is an international computer network that was developed to provide students from different cultures the opportunity to work together on joint educational activities (Cohen, 1986). Students in Mexico, Japan, Israel, and the United States participated in the project. The students in Japan used English, the second language they were studying, to complete their projects. Students showed a great motivation to use English to communicate through network activities. Test scores demonstrate that the students in Japan gained English proficiency through these network activities. The students agreed that the language they learned in networking activities was a living language.

In the study conducted by Soh and Soon (1991), two groups of teenage students from two cultures (Singapore and Canada) communicated via e-mail. Researchers found that the students learned to write clear and effective prose to communicate their ideas and concepts. In addition, the students learned that the computer can be an effective communicative tool as well as a learning tool.

Although a search of literature failed to locate any research on using e-mail as a writing medium in dialogue journaling, the literature discussed above establishes the educational value of using e-mail and dialogue journaling on paper as educational tools. The present study involved designing an electronic-based dialogue journaling environment to explore whether the two tools can be combined to create an effective learning environment in the ESL writing classroom.

The Study

This case study involved designing an electronic-based environment to explore the effectiveness of e-mail as a writing tool for dialogue journaling. The issues investigated were: What were the students' attitude toward dialogue journal writing via e-mail? What was the instructor's perception regarding e-mail dialogue journal writing? What problems occurred in the process of using e-mail as a tool for dialogue journaling? In what ways, were e-mail journals different from paper journals?

Setting and Participants

The setting in the present study was an intermediate level reading and writing class in the American English Institute (AEI) on the campus of a large public university. The research covered a period of nine weeks.

There were fourteen students in the class. Half of the students were randomly assigned to the e-mail group, taking into consideration of gender and nationality.. The other half of the students in the class were assigned to the paper-and-pencil group.

It needs to be pointed out that one student was included into the e-mail group as a special case. Two weeks after the project started, one student from the e-mail group dropped. One student (Hiroko) from the paper group volunteered to join the e-mail group. Since the nature of this research is qualitative, the researcher gave her the permission. Another consideration was that it might contribute insightful information to the study to have a subject who had experience using both medium.

During the term, some students dropped the class, some students had long illness and some students had poor attendance. These students were excluded from the sample in the present study. The final student samples are shown in table 1 and table 2.

TABLE 1. Student Sample (E-mail Group)

Student	Nationality	Gender	Final grade for the term
Ying	Taiwan	Female	88.8
Lin	Taiwan	Male	90.5
Toshi	Japan	Male	67.8
Tamiko	Japan	Female	85.3
Hiroko	Japan	Female	91.6
Andi	Indonesia	Male	81.0

TABLE 2. Student Sample (Paper and Pencil Group)

Student	Nationality	Gender	Final grade for the term
Meimei	Taiwan	Female	84.0
Shen	Taiwan	Female	92.0
Atzko	Japan	Female	90.8
Hiro	Japan	Male	75.3

Dialogue Journal Writing Procedure

The students in both groups wrote dialogue journals outside of class time. The students in the e-mail group sent their dialogue journals to the instructor by the use of e-mail every day. They used the computer lab in AEI program on the campus. The students in the paper-and-pencil group wrote their dialogue journals on pieces of paper and handed them in to the instructor every morning before the class started.

The instructor used e-mail to write to the students in the computer group and an electronic typewriter to write to the students in the paper group.

Data Collection

A triangulation strategy was used for data collection in the present study. Data collection methods in the present study included: (a) classroom and lab observation; (b) interviews; and (c) the collection of the dialogue journals written by the students and the instructor in both e-mail group and paper group.

Classroom observation

The researcher attended the class three times a week to do classroom observations. Detailed field notes were taken during the observations on how the class was organized, how the instructor interacted with the students, and what activities the students did in the class. Participant observation allowed the researcher to view the research in a broader context and provided the researcher a better understanding of how other factors might affect the results of the research.

Interviews

The researcher did informal interviews with the students and the instructor before class started or during class breaks. A semi-structured interview was conducted at the end of the project and follow-up telephone interviews were conducted four months later after the project was over.

Collection of the dialogue journals

An aliases file was built into the e-mail account of each student and the instructor in order to collect the dialogue journals written by the students and the instructor via e-mail. The aliases were designed so that the dialogue journal entries written by the students and the instructor via e-mail were automatically sent to the researcher as well as to their specified receiver.

The paper journals were collected weekly. Each Friday the students in the paper group were required to bring all the journals they wrote during the week and hand them in to the instructor. The instructor made copies of the paper journals and gave the copies to the researcher.

Data Analysis

Data analysis was based on interviews, field notes, and the written dialogue journals (e-mail and paper and pencil) produced by the students and the instructor. Data was categorized and organized to describe the subject's attitude towards using e-mail as a medium for writing the dialogue journal and the problems that the participants encountered in the process of using e-mail.

To compare e-mail journals and paper journals, Shuy's model on sentence level language function serve as the guideline for coding the dialogue journals. Language functions are the ways in which people use language to get things done: "They may want to tell something, to answer a question, complain, apologize, promise something, or any number of other things. These are all referred to as language functions" (Shuy, 1988, p. 107). Shuy (1982, 1988) developed his model in analysis of the dialogue journals written by a teacher and 10 students over a period of two weeks in the fall and in the spring. "This analysis of language functions is based on the strong belief that language functions are a more effective measure of writing abilities than any existing measure of language forms" (Shuy, 1988; p.142). Ten frequently-used language functions were identified in the dialogue journals in the present study: (a) reporting opinion, (b) reporting personal facts, (c) reporting general facts, (d) responding to questions, (e) predicting, (f) complaining, (g) giving directives, (h) apologizing, (i) thanking, (j) offering, (k) promising, and (l) requesting.

The reliability of data coding was checked by hiring the other coder to code the data. One hundred-twenty sentences (2%) were randomly selected. The methodology used for random selection was stratified random sampling. First, the total number of the sentences was divided by the number of the sample to be selected (5812/120=48). Second, the sentences were grouped according to the categories of language functions. Different categories of language functions were entered into different computer files. Third, the sample was selected consisting of each 48th sentence in each category of language functions.

After the training, the coder coded the data independently according to the coding rules. The results of his coding showed that out of 120 sentences, the coder correctly coded 106 sentences The reliability of the data coding in the present study was 88.3% (106/120=.883).

Findings and Discussions

Attitude towards using e-mail in dialogue journaling

Five out of six students expressed a positive attitude towards using e-mail in dialogue journaling. They were Lin, Andi, Hiroko, Toshi and Ying. They preferred using e-mail to using paper and pencil. Ying enjoyed using e-mail, but she mentioned she would not mind using paper and pencil as well in writing dialogue journals. These students commented that e-mail is fast, fun and convenient. Tamiko held an attitude of total rejection towards using e-mail.

Both Lin and Andi had computer background and typing skills. They expressed positive attitudes towards the use of e-mail. Based on observations in the computer lab during e-mail training, both students handled the dialogue journal typing task with ease. Each of them spent about 10 minutes a day in writing their dialogue journals. The 10 minutes figure is in sharp contrast with the average of 30 minutes spent by the other e-mail users and the paper-and-pencil students. These two students enjoyed using e-mail because they were familiar with the computer technology and they did not have difficulties in typing. They felt it was easy and convenient for them to write via e-mail.

> When I use e-mail, I have enough time and it is easier to edit. I feel it is better for me. I feel it is very troublesome to write by hand. When I write by hand, I have to erase by using the eraser. After that, I have to try to make the paper look clean. I really feel it is very troublesome to do so. My handwriting is very poor. It was also faster for me to write by the computer than to write by hand. (Lin)
>
> *Researcher:* *What did you like most about e-mail writing?*
>
> *Andi:* *Typing.*
>
> *Researcher:* *Typing?*
>
> *Andi:* *Yes.*

Researcher: *You like typing better than handwriting?*
You'd rather type than to write by hand?

Andi: *Yes.*

Among the students who did not have computer background and typing skills, Toshi, Hiroko and Ying expressed positive attitudes towards e-mail. Toshi, Hiroko and Ying were very enthusiastic about learning the computer technology and typing skills. During the interviews, these three students identified that by doing e-mail dialogue journals, they could learn typing and computer technology. The following excerpts of their dialogue journals indicated that they thought that it was important for them to learn the computer technology and typing skills for their future careers. Their attitude towards e-mail was affected by their desire to learn the computer technology and typing skills which they considered relevant to their career goals.

> (Ying)
> It is a nice thing that I can talk to you by using my fingers. This is a very special experience to me. If I can be a regular student, I might have my own e-mail account. I hope I still can talk with you.
>
> (Hiroko)
> Hi! This is Hiroko. This is the first time to send you my letter. Since I only learned how to use computer yesterday, I ought to be at a loss. However, I think it's very important to learn to use computers which are indispensable to future. And that, secretary whom I want to be also need the skills of using computer. Now it is the time to learn it. I will do my best!! See you.
>
> (Toshi)
> I am sorry. I forgot to reply your message. Here are my answers. I like to use computer. Therefore, I used computer every day. Also, I like to write something. So, I hope that I want to use computer next term. I was looking for use computer and to communication by write to American people. If you can do this program next term, please tell me.

E-mail participants considered it an advantage that they did not need to coordinate a time to communicate with each other, they did not need to deal with paper work and they could concentrate on their writing in an e-mail environment.

> I saw another group turned in their journals early in the morning in class every day. I feel it is very troublesome. I don't like to do that. It turns the dialogue journal writing into formal homework. It is very convenient for me to use the computer. All I need to do is to turn on the computer. (Lin)

Andi: *... because when I was writing in my apartment, I leave my writing, and I'll go anywhere. After that, I'll continue again. Then I have something to do, and then back to write.*

Researcher: *So you think there are lots of distractions at home? But with the computer, you can concentrate, just ten minutes?*

Andi: *Yeah, just ten minutes.*

Researcher: *OK. What inconvenience does e-mail bring to your writing?*

Hiroko: *Eh....*

Researcher: *Compared with writing by paper and pencil?*

Hiroko: *Oh. I think writing in paper is more inconvenient. I think e-mail is more convenient.*

Researcher: *Can you tell me why?*

> *Hiroko: Because, I do not need to prepare drafts. Paper writing, I have to write the day before. In the morning, I have to submit to the instructor. But e-mail is...can send thinking fast...I think e-mail is more convenient.*

Tamiko held a negative attitude towards using e-mail as a writing medium in dialogue journaling. She thought e-mail is "so so." She did not like to use e-mail to write her dialogue journal. She felt the computer letters were impersonal. In addition, she even did not want to consider using e-mail as a communication tool in the future.

Another frustration that Tamiko felt about using e-mail was that she could not make corrections, even when she found the mistakes while she was writing via e-mail:

Tamiko's view about errors affected her attitude towards the dialogue journal. She had considerable anxiety about the errors she made in her writing. From the very beginning, she requested the instructor to correct her writing errors in her dialogue journals:

> (Tamiko)
> Hello! Karen. How are you. I am very fine now, because I am done all my class and test. However I already found some mistakes. By the way, I have question. I don't know what should I do for my free-writing [the dialogue journal]. I think I always have many mistake in my writing. However I don't know what is my mistake. So, could you tell me about that? See you next Monday. Have a nice weekend! Bye!

Tamico's attitude towards e-mail was affected by her error phobia, her attitude towards dialogue journaling and this was compounded by her lack of typing and computer skills.

If viewed from a broader context, Tamico's attitude was affected by a powerful reality: the TOEFL test, a test required for all foreign students who want to be admitted to universities and colleges in North America. The classroom observation indicated that the classroom instruction was attuned to the requirements of the TOEFL test, that focuses on grammar and vocabulary. The approach of dialogue journaling in language learning, however, is in conflict with preparing to pass a TOEFL test. In informal interviews and in their journal entries, the students openly expressed their worries about spending too much time writing dialogue journals which was irrelevant to preparation for the TOEFL test. Comparatively speaking, the students in the e-mail group were facing a greater challenge than the students in paper group. The students in e-mail group had to handle an entirely new writing environment.

The instructor enjoyed using e-mail to conduct dialogue journaling. When asked to compare the two mediums, the instructor thought she had better communication with the students in the computer group than with the students in the paper group. In fact, she spent more time writing to the students in the computer group.

> Karen: I think I spend more time on the computer group. And it was direct communication. They wrote to me and I wrote back, the same topic, back and forth, back and forth. Well, with the paper group, we were discussing one topic on Monday and what I received on Tuesday morning was a different topic, so sometimes I did not have too much to say, and then they go back on Monday's topic, but I would forget what I said on Monday. So it wasn't a good flow of communication with the paper group.
>
> Researcher: So which group do you spend more time writing to?
>
> Karen: With the e-mail group, I think.
>
> Researcher: Oh. You spend more time because you have something to say to them?
>
> Karen: Yeah. Because I would ask them questions and they responded to the questions, back and forth, back and forth. But with the other group, I asked them questions on Monday, and I wouldn't get response till Wednesday. So it just didn't seem as communicative as e-mail.

Another reason why the instructor liked to use the computer for dialogue journaling was that she could have all the students' writings saved in the computer, and it was convenient for her to refer to what the student had previously written.

Researcher: How would you compare the two different mediums? You are using the computer and you are using typewriter.

Karen: How would I compare them?

Researcher: Yeah. The computer medium and the paper medium.

Karen: OK. I have not thought about this before. I prefer the computer for almost everything that I do, but I don't know exactly why. If I say it saves time, then it is true. But I don't know if it was expected to save time.

Researcher: Did you feel it was troublesome to exchange folders with the paper group every day?

Karen: But I have been doing this so long. You know, it would be nice not to have to distribute folders every day, collect and return. That sounds good. I know one thing that I like better about the computer is that I can keep all their writings in the folders, that I can look at them at any time, whereas the paper group, once they took back their papers, I never saw them again. So I can go back in their folders, I can look three or four days back if I wanted to, but I could not do that with the paper group.

It is obvious that each individual's attitude toward e-mail was affected by a variety of factors, such as personal computer background, typing skills, perception of the writing process, attitude toward learning technology, and a sense of relevance of the present project to their imminent academic goals and future academic goals. These factors combined together to exert an influence on their attitude toward e-mail as a writing medium in dialogue journaling. No single factors alone determined their attitude.

Problems encountered in using e-mail

Typing

The students who did not have typing skills usually spent about thirty minutes in writing a dialogue journal entry. Ying spent an even longer time than that. She thought that one of the reasons why she spent so much time writing every day was that she typed slowly. Both Toshi and Hiroko reported that they spent time thinking about keyboarding while they were writing.

Limited Access to the Use of Computers

All the students in the study reported that sometimes a computer was not available to use when they went to the computer lab to write. During the fall term, the computer lab in the AEI program was very crowded. There was always a line of students waiting to use the computers. Tamiko reported that she twice missed writing because she could not get access to a computer. Other students reported that they had to spend a lot of time waiting in lines.

E-mail System

Some of the students felt frustrated with the editing functions provided by the e-mail system. The e-mail system used for the present study did not provide the types of editing functions and other aids to writing that one finds in a modern word processor. The students could not use a spelling checker to correct their spelling. The students could not use the computer mouse to move the cursor to the places where they wanted to make changes. They had to use the arrow keys to move the cursor line by line to the place they wanted to make changes. Often the appearance of the whole screen display was spoiled when changes were made.

However, it needs to be pointed out that this editing problem is specific to the e-mail system involved in the present study. It should not be generalized to other e-mail systems.

Students' dissatisfaction with the e-mail system sometimes was not caused by the system itself, but by their limited knowledge about the system. For example, Ying mentioned that she could not refer to the journal entries she had previously made, because they had been sent on to the teacher. Actually, it would have been quite easy for her to save a copy of each message she sent. These e-mail difficulties suggest that the initial training, although adequate to get students started, needed to be supplemented by additional training. The additional training needs to review important features that students have not learned to use, and to present additional features that they may find useful.

The Computer System Malfunctioned

A few times, the participants reported that the computer system malfunctioned. The researcher did not work with the students in the computer lab all the time, so it was difficult to identify what the specific problems were. Problems might be caused either by the computer network system or by inappropriate operations on the part of the student. The computer problems caused frustration for the students, because most of them did not have any computer background. It should be noted that the computer problems happened very infrequently. Generally speaking, the computer network system functioned well throughout the study.

Differences between e-mail journals and paper journals

The comparison of the language functions used in e-mail journals and paper journals revealed three patterns. The participants in the e-mail group tended to use formula function, requesting function, and tended to produce more language functions per writing session compared with the participants in the paper group. Supported by the other findings of the differences between e-mail journals and paper journals, the present study indicated that e-mail created a different writing mode when it was used for dialogue journaling in a classroom setting.

Formula Functions

Formula Functions refer to openings and closings in dialogue journal entries. The students in the e-mail group tended to use formula functions while the students in the paper group did not (see table 3). The students in the e-mail group often greeted the instructor at the beginning of their writings: "Hi! How are you today?", "Good morning, Karen.", "Hello, Karen, this is Lin.", "Hi! This is Toshi. How are you doing?". They used closings at the end of their writings: "See you tomorrow," "See you in class," "Bye-bye," "Have a good day." None of the students in the paper group used any of these formula functions.

The instructor used more formula functions in writing to the students in the e-mail group than did she to the students in the paper group (see table 4).

TABLE 3. Ranked Comparison of Formula Functions Used by the Students in the Two Groups

Student	Opening N	Closing N	Total N	Formulas Per Writing Session N
E-mail Group				
Lin (36)	60	28	88	2.44
Tamiko (38)	53	55	88	2.32
Ying (47)	11	45	56	1.19
Toshi (42)	14	22	36	0.86
Hiroko (24)	1	9	10	0.42
Andi (29)	0	0	0	0.00
M=	23.17	26.5	46.33	1.21
Paper and Pencil Group				
Atzko(37)	0	0	0	.00
Shen (37)	0	0	0	.00
Meimei (27)	0	0	0	.00
Hiro (20)	0	0	0	.00
M=	0	0	0	.00

Note: Numbers in parentheses are the total numbers of writings each student did in the program.

TABLE 4. Ranked Comparison of the Formula Function "Closing" Used by the Instructor Per Writing Session in Response to the Students in the Two Groups

Instructor to Student	Closing (Total Numbers) N	Numbers Used Per Writing Session N
E-mail Group		
Lin (36)	15	.42
Ying (47)	14	.30
Toshi (42)	11	.26
Tamiko (38)	11	.29
Hiroko (24)	5	.21
Andi (29)	5	.17
Paper and Pencil Group		
Atzko(37)	4	.11
Shen (37)	4	.11
Meimei (27)	2	.07
Hiro (20)	0	.00

The finding that the students in the paper group did not use formula functions agrees with the findings of previous studies conducted on paper journals. In both Shuy's studies (1982, 1988) and Gutstein's study (1983), the students used formula functions infrequently in their paper-and-pencil dialogue journals.

Due to its perceived speed, e-mail writing in fact closely parallels a phone conversation or face-to-face conversation (Baron, 1984; Bolton, 1991; Dubin, 1991; Murray, 1991). In a phone conversation or face-to-face conversation, people frequently use formula functions.

Though the participants in the e-mail group tended to use formula functions in their writings, they did not consider it a rule for them to follow. They were flexible in using formula functions. Sometimes they used both openings and closings. Sometimes, they used only openings or only closings. One student never used any openings and closings in his messages.

Requesting Functions

Another obvious difference is that the students in the computer group asked more questions than did the students in the paper group (see table 5).

TABLE 5. Ranked Comparison of Questions Asked by the Students in the Two Groups

Student	Total Questions N	Questions Per Writing Session N
E-mail Group		
Ying (47)	57	1.21
Hiroko (24)	27	1.13
Tamiko (38)	21	0.55
Andi (29)	15	0.52
Toshi (42)	17	0.40
Lin (36)	12	0.33
M=	24.83	0.69
Paper and Pencil Group		
Atzko(37)	12	0.32
Shen (37)	9	0.24
Meimei (27)	3	0.11
Hiro (20)	0	0.00
M=	6	0.17

This finding is consistent with the findings of previous studies conducted on using e-mail as a communication medium in a variety of settings. The previous studies indicate that e-mail users tend to ask questions and seek information in e-mail writings. Rice and Case (1983) did a study on the patterns of e-mail communication among e-mail users on the campus of a university. They found that the highest uses of e-mail were to exchange information (100%), ask questions (95%), discuss opinions and keep in contact (84%). Schaefermeyer and Sewell (1988) conducted a survey on how e-mail was used among e-mail users on BITNET (one of the largest academic networks in the world). The results of their survey showed that the major use of e-mail was to seek information. Grabowski et al. (1990) conducted another study on the use of e-mail among graduate students in a university. They found that exchanging academic information (100%) and discussing ideas (63%) comprised the highest uses of e-mail in the population of their study. Sherblom (1988) did a content analysis of the e-mail messages received by a middle-level manager in a large organization over the period of several months. The findings of the study showed that requesting information and providing information comprised the largest part of the content of all the e-mail messages received by the manager.

The fact that e-mail participants tended to ask more questions could be due to their perceptions of the medium. E-mail is fast. When a person asks questions, the usual desire is to receive responses as quickly as possible. The e-mail user may have a perception that a message is being sent rapidly and is immediately received by the addressee. This perception of speed fits the student's need to get immediate responses to their questions. In actuality, the instructor only responded to the student's writing once a day. The students usually got the responses from the instructor the next day. It is the students' perception of the medium that facilitated question asking.

The perception of speed may be linked to the feeling that once an e-mail message is sent, a communication task has been completed. This perception contrasts with writing on paper where it is possible to continue to make additions until the paper is physically turned in to the teacher. This delay might account for the fact why the paper group students asked so few questions.

Overall Language Functions

Comparison of the language functions used in the e-mail dialogue journals and the paper dialogue journals indicated that the students in the e-mail group either produced as many language functions or they produced more language functions per writing session than did the students in the paper group (see table 6). The instructor produced a greater number of language functions per writing session in the e-mail group than in writing to the students in the paper-and-pencil group (see table 7).

The conversational and informal style of e-mail dialogue journaling might have encouraged the students and the instructor to write more. E-mail dialogue journaling is closer to oral communication than paper dialogue journaling is. E-mail participants do not need to pay as much attention to the rules that are required in formal writings. In Kinkead's study, she observed the conversational nature of e-mail writings: "These writers often refer to E-mail as holding a conversation since its informality almost demands that they write the way they talk, breaking down the rigid rules of more formal communication" (Kinkead, 1987, p. 341).

The informal and relaxing environment facilitated communication between the instructor and the students. The students lost the constraints and inhibitions the intended audience provided. They no longer feel bound by formal instructor-student relationship. As one student mentioned in her e-mail journal:

> It is a nice thing that I can talk to you by using my fingers.
> I like to use this way talk with you. This is a very special experience to me. You know? In my country, students have to call teacher "Teacher", sounds very serious. (Ying)

E-mail made the process of communication between the students and the instructor easy and convenient. Some students mentioned that e-mail is fast and convenient. The students and the instructor did not need to coordinate a time to communicate with each other. Both the students and the instructor considered it an advantage that they did not need to deal with paper work when they wrote via e-mail. This added convenience may have encouraged them to write more.

The computer itself probably provided a motivation for the students and the instructor to write more. The instructor and most of the students indicated that they enjoyed working with the computer. Some of the students felt it was fun to write using the computer. Some of the students considered it important for them to learn to use the computer technology. They were willing to spend more time writing with the computer because they felt the task of learning the technology was relevant to their future careers.

TABLE 6. Ranked Comparison of the Means of Language Functions Use by the Students in the Two Groups Per Writing Session

	Frequency of Language Function Use for Each Student	
	Total of Language Function Use	Mean of Language Function Use per Writing Session
E-mail Group		
Ying (47)	768	16.34
Lin (36)	573	14.74
Hiroko (24)	531	14
Toshi (42)	515	13.63
Tamiko (38)	336	13.55
Andi (29)	253	8.72
Paper and Pencil Group		
Shen (37)	379	10.24
MeiMei (27)	333	12.33
Atzko (37)	315	8.51
Hiro (20)	228	11.44

TABLE 7. Ranked Comparison of the Means of the Language Functions Used by the Instructor to the Students in Both Groups Per Writing Session

	Frequency of Language Function Use for Each Student	
	Total of Language Function Use	Mean of Language Function Use per Writing Session
E-mail Group		
Ying (47)	311	6.62
Lin (36)	191	5.31
Hiroko (24)	135	5.63
Toshi (42)	191	4.55
Tamiko (38)	193	5.08
Andi (29)	148	5.10
Paper and Pencil Group		
Shen (37)	142	3.84
MeiMei (27)	93	3.44
Atzko (37)	118	3.19
Hiro (20)	59	2.95

Other Findings

The present study also indicates that e-mail creates a different writing mode. Conversational cues were found in e-mail messages. In e-mail dialogue journals, the students and the instructor used conversational cues such as "Wow", "OOPS", and "Yuck."

> (Ying)
> Wow! I am very glad since you told me such clear and interesting answers.
>
> (Hiroko)
> I will go to the football game on Saturday and also go shopping on Sunday. Besides, my friend when I was high school student will come to Eugene. So I somehow can break off my frustration during this weekend. OOPS!! I have two TEST next week!
>
> (Instructor)
> Lice! Yuck! Yuck! Kids in public schools often get this and it is very, very difficult to get rid of it.

The students in the e-mail group in the present study wrote more informally and casually than did the students in the paper-and-pencil group. They wrote as if they were holding a conversation. "Since e-mail often flies between parties at a rate approaching a conversation, and since most people are more comfortable being friendly than combative, many people tend to drift into informality in their electronic messaging" (Krol, 1992, p. 93). Comparing the difference between e-mail writing and paper writing, Hawisher and Moran (1993, p.630) pointed out: "E-mail seems now to employ a language that is somewhere on the continuum between spoken and written language.... But often, e-mail is composed on-line, and rapidly. Typically it is not subjected to the reflective scrutiny we usually give to the language we inscribe on paper."

The sentence structures in the e-mail dialogue journals were looser than those in the paper writings. Indenting, paragraphs, and punctuation were used very casually. The students in the paper group arranged their sentences more carefully, as if they were doing formal writing assignments.

The writing process can also explain the differences between e-mail journals and paper journals. Interviews (both informal and semi-structured) revealed that paper group students used dictionaries and grammar books quite frequently while they were writing dialogue journals. Sometimes, they wrote drafts. E-mail writing requires a high degree of the engagement of mind and hands. An e-mail writing environment does not encourage students to use dictionaries, grammar books or write a draft as it did with the students in the paper group. One e-mail participant used a dictionary a couple of times at the beginning and gave it up because it slowed him down in his composing. Hiroko was an interesting case. She used to write by using paper and pencil for two weeks and then she volunteered to joined e-mail group. When she wrote by the use of paper and pencil, she always wrote drafts. She spent about 30 to 60 minutes to write her paper journals. When she wrote by the use of e-mail, she did not prepare drafts and she spent less time. When asked whether she wrote the same way by the use of the two different mediums, Hiroko answered that she did not think so.

> *Researcher: Yeah. Because you have this experience, at the beginning, you wrote by using paper and pencil, and then you moved into the computer group. So I want to know what you think. Do you think you wrote the same way by using the two mediums?*
>
> *Hiroko: No.*
>
> *Researcher: Can you tell me the difference?*
>
> *Hiroko: Writing using the paper is to have a time to think. E-mail is, I always can only think about it at this time.*

Here Hiroko pointed out the difference between e-mail dialogue journals and paper dialogue journals: unplanned vs. planned. E-mail writing, like a telephone or face-to-face conversation, is spontaneous

Implications

The results of this study are not conclusive. The sample of the study was obviously limited. However, this project was a success and suggests important implications in utilizing e-mail as a medium to conduct dialogue journaling in ESL classrooms.

E-mail provides an alternative tool for students to use for dialogue journaling. While it is not appropriate to assume that e-mail is the tool that should be used by every student in dialogue journaling, the unique features of e-mail do appeal to some students and thus offer them a choice. E-mail is a handy tool for students who have difficulties in handwriting and who are interested in using computers.

E-mail has evident advantages over paper and pencil when dialogue journaling is conducted outside of class. Many ESL teachers conduct dialogue journaling during class time. However, with limited class time to cover course materials, teachers might find it difficult to devote 15-20 minutes to dialogue journaling each day. E-mail provides an ideal environment for dialogue journaling outside of classroom. It eliminates the problems of having to coordinate a communication time and the hassles of having to deal with paper work.

E-mail can also play a role in changing inappropriate student writing habits. Student writers, especially ESL beginning writers tend to edit their writing prematurely in their writing process. The present study found out that this problem persisted even when the students were doing dialogue journaling, which is a type of freewriting practice. E-mail provides a writing environment which encourages students to put down their thinking as fast as possible without spending too much time agonizing on words, phrases, grammar and sentence structures. ESL students can use e-mail to get used to freewriting and practice their writing fluency, by just focusing on communication.

E-mail dialogue journaling in the present study was conducted between the instructor and the student. However, the unique features of e-mail can easily expand the dialogue journal beyond the range of the student and the instructor. During the interviews, the students in the present study expressed a strong desire to communicate with each other via e-mail. In doing e-mail dialogue journaling, the students can be paired with other students at a higher language level. The students also can be paired with other competent language users on or off the campus. In this way, e-mail offers the opportunity for ESL students to interact with more people with whom they are interested and who can help them in their written language acquisition.

The discussion of the potential of e-mail in writing must also take into consideration the continuing rapid changes in computer technology. Voice input to computers is just now becoming available at a price that an ESL lab can afford. Such voice input can be used to produce a text message that can then be sent via e-mail system. When the students can actually speak to the computer and the computer types the message for the students, when the students can not only read the message, but also be able to hear the message, how is that going to affect the production of written language?

Stotsky (1983) postulates that the relationship among the language skills is not only reciprocal, but also multidirectional. She considered that all four language skills (reading, writing, speaking and listening) influence each other and enhance each other. If this theory is valid, we can expect that the availability of voice input in an e-mail system will not only enhance the development of the writing skills of ESL students, but will also enhance the development of the speaking and listening abilities of ESL students.

Guistein (1983) stated that the fluent writer uses language functions appropriately in a wide range of contexts. E-mail provides students another context in which they need to achieve competence. E-mail is an important communication medium in the real world. Students should be prepared for an e-mail communication environment. "We need to introduce them to e-mail as an aspect of the work environment" (Hawisher & Moran, 1993, p. 638).

At the present time, the use of e-mail is increasing at a speed of over 300,000% a year (Stonehill, 1993), however, "the acceptance of e-mail in academic setting has been less than lukewarm" (D'ouza, 1991, p. 106). In the field of composition, "electronic mail has received scant attention" (Hawisher & Moran, 1993, p. 627). E-mail is largely used as a personal communication tool among faculty members and researchers. The function and impact of e-mail as an instructional tool have not been adequately explored. The present study suggests that e-mail is a valuable tool in a writing class. As Hawisher and Moran (1993, p. 638) pointed out: "We writing teachers need to pay attention to e-mail in our writing classes because it is here, because it is a means of written communication, and because we as academics are using it. E-mail, we believe, deserves a place in the curriculum."

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Title:

Cognitive Learning Styles And Their Impact On Curriculum Development And Instruction

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INTRODUCTION

PURPOSE OF STUDY

The study of cognitive styles is not new in the field of educational psychology. The earliest recorded research was conducted at the turn of the century by German psychologists (Coop, 1971). Over 3,000 research studies to date have been conducted in the field of cognitive psychology. According to Chinien and Boutin (1992-93), cognitive styles are defined as the "information processing habits representing the learner's typical mode of perceiving, thinking, problem solving, and remembering." Cognitive style is concerned with how an individual processes information. This includes any process which acquires knowledge (e.g., memory, perception, thought, and/or problem solving). Cognitive styles are not likely to change with time or with training (Ausburn & Ausburn, 1978 and Witkin, Oltman, Raskin, & Karp, 1971). Technology, information systems, and computer based training should, therefore, be tailored to the individual most likely to utilize that system. Conversely, if systems are already in place and cannot be easily adapted or changed, individuals who possess the appropriate cognitive abilities should be selected to use these systems. In a 1994 study, Lyons-Lawrence stated that materials that "stimulate one (individual) may be confusing, distracting, and difficult for another, and too simple for a third." Individuals with various learning styles differ in their performance when using technology. For example, working with computers may be unsuccessful or unproductive if the individual is not visually oriented (Lyons-Lawrence, 1994).

Cognitive style is also not a single entity. Most educational psychologists recognize nine to eleven major dimensions of cognitive style including: scanning; categorizing; reflectivity/impulsivity; and field independence/field dependence (Whyte, 1990 and Whyte, Knirk, Casey, & Willard 1990-91).

Although many cognitive styles have been identified and researched, there have been very few studies which have sought to correlate different measures of cognitive style into a "multidimensional construct" (Kini, 1994). Since there would be a clear advantage to identifying such a construct we attempted to map the "typical" USAF leader of today and tomorrow by seeking to establish a cognitive map of the students and Field Grade officers (i.e., the ranks of Major and Lieutenant Colonel) in the Air Force today.

COGNITIVE STYLE

Cognitive Style Defined

Messick (1976) defines cognitive learning styles in the following quote; "Cognitive learning style helps explain how an individual responds to a wide range of intellectual and perceptual stimuli. Each person's style is determined by the way he takes note of his total surroundings...how he seeks meaning, how he becomes informed. Messick (1984) contains perhaps the most complete discussion of cognitive style available. In his article, Messick defines cognitive style as "characteristic self-consistencies in information processing that develop in congenial ways around underlying personality trends." He also states that cognitive styles are "intimately inter-woven" with motivational, affective and temperamental structures to produce total personality. Perhaps the most prolific writer in the area of cognitive styles was Herman A. Witkin. As part of their extensive research, Witkin, Moore, Goodenough and Cox (1977) determined that cognitive styles: 1) deal with the "form" of cognitive activity, not its content (e.g., thinking, perceiving, problem solving, etc.); 2) are "pervasive dimensions" in that they are a feature of not only personality but also cognition; 3) are stable over time; and 4) are also bipolar. In other words, being on one end of a cognitive style dimension may be useful in some circumstances while not in others. This aspect is in contrast to intelligence, for example, where "more" is always "better."

It is also significant to note that there appears to be a negligible relationship between cognitive style and general intellectual ability. (Ausburn & Ausburn, 1978 and Witkin, Oltman, Raskin, & Karp, 1971). Ausburn (1978) notes that these relationships are extremely negligible and fall short of statistical significance. Although the relationship between IQ and cognitive style appears to be questionable many researchers encourage controlling for intelligence when investigating interactions between cognitive styles and other variables (Ausburn & Ausburn, 1978; Rosenberg, Mintz & Clark, 1977; and Wachtel, 1972).

Related to this research, Witkin, Moore, Oltman, Goodenough, Friedman, Owen and Raskin (1977) determined that there is very little relationship between overall college achievement (i.e., grade point average) and cognitive style.

Studies have shown, however, relationships of cognitive styles and performance in specific subject areas. For example, field independents tend to do better academically in math, science and engineering.

Cognitive style is also not a single entity. Jonassen and Grabowski (1993) list twelve different individual cognitive styles/controls including: 1) Reflectivity/Impulsivity; 2) Focal Attention (Scanning/Focusing); 3) Serialistic/Holistic; 4) Field Independence/Field Dependence; 5) Flexibility (Constricted/Flexible); 6) Category Width (Narrow/Wide); 7) Automization (Strong/Weak); 8) Visual/Haptic; 9) Visualizer/Verbalizer; 10) Leveling/Sharpening; 11) Analytical/Relational; and 12) Complexity/Simplicity.

Implications of Cognitive Style on Computer Utilization

In their 1994 article dealing with "Attributes Affecting Computer-Aided Decision Making," Moldafsky and Kwon state that, cognitive style refers to the characteristic processes individuals exhibit in the acquisition, analysis, evaluation, and interpretation of data used in decision making and has been shown to influence a decision maker's evaluation of an unstructured, strategic planning problem. Recent research has shown a strong link between an individual's cognitive style and their reactions to computer assisted instruction (CAI) or computers in general. According to Moldafsky & Kwon (1994), research indicates that cognitive style can be responsible for an individual's skill in information processing, decision-making attitudes toward computers, and computer anxiety. In 1994, Hsu, Frederick, and Chung found that individuals with particular cognitive styles significantly outperformed others in the recall of the content of computer based instruction. Rowland and Stuessy (1988) is an example of a study which matched alternative modes of CAI to cognitive style. They found that cognitive style, in this case holists and serialists, interacted with various modes of CAI to influence student achievement. Burger (1985) further supports this notion. Her research is another example of a study which investigated the interaction of this particular cognitive style (i.e., field independence/field dependence) and preference for and academic achievement in computer assisted instruction.

Cognitive Style and Information Processing

To provide one clear example of the differences cognitive style can make between individuals in information processing, at this point we will specifically use Field Dependence/Independence, to describe researched processes, since it is the most widely researched style we included in this study. Witkin, 1977, found that individuals with various cognitive styles, in this case field independents (FIs), are able to precisely identify the critical information contained in a complex visual environment. Field dependents (FDs), on the other hand, generally do not mentally restructure a visual presentation. FDs accept and interact with information the way it is presented (Witkin, 1977 and Dwyer & Moore, 1992). These facts have strong implications for intelligence gathering, information processing, and the critical analysis of visual information. Flannery, 1993, found that FDs process information in a "simultaneous manner." Ideas are seen all at once rather than in some observable order. If information is not connected to something the individual values, it (the information) is discarded. FIs use logical, inductive, information processing. They perceive information objectively. Information for FIs does not have to be concrete or personalized (Flannery, 1993).

PROJECT DESIGN/PARTICIPANTS/MATERIALS

Project Design

In order to attempt to correlate different measures of cognitive style into a "multidimensional construct", we decided to utilize three existing test measurements: Gestalt Completion Test, testing Cognitive Flexibility; Kolb Learning Styles Inventory, evaluates the way individuals learn and deal with ideas and information in day-to-day situations; and Group Embedded Figures Test (GEFT), which determines field independence/dependence. These tests were selected due to their reliability factors and to provide the best description of the "typical" United States Air Force officer cognitive style.

Participants

Selection of participants used in the study came exclusively from the United States Air Force Academy. Current officers at the Major, and Lieutenant Colonel level volunteered to participate in this study and thus represent the officers of today in this study. They were recruited from across educational disciplines, backgrounds and career fields. Information collected about each officer participant included gender, age, rank, number of years of school completed, undergraduate major, graduate major, last degree granted, number of courses completed in computer science, source of commissioning, primary AFSC/Career Field, amount of Professional Military Education completed, ethnic group and nationality.

To represent the Air Force officer of tomorrow, we surveyed the current cadet population at the Air Force Academy. We randomly selected senior and junior undergraduate level students. These students included cadets in leadership and non-leadership positions, randomly placed by the registrar in class sections of core Military Art and Science courses. We collected information from each cadet participant on gender, date of birth, class level, number of courses completed in computer science, ethnic group, nationality, and academic major.

The three cognitive styles tests were administered to all participants in classroom environments. They were typically all administered at one sitting. On occasion the GEFT tests were administered in one class session and the other two tests in a different class session due to class time availability. This is not seen by the researchers as a confounding factor since the tests do not build upon each other in any way. All tests were collected, scored, and data compiled through the use of SPSS.

TESTING MATERIALS

GROUP EMBEDDED FIGURES TEST (GEFT)

The Group Embedded Figures Test (GEFT), measures the cognitive style dimension of field independence and field dependence. The GEFT consists of 18 complex figures. Individuals must find a simple embedded geometric figure which is hidden in a complex one (Donlon, 1977; Thompson & Meloncon, 1987; Willard, 1985 and Witkin, Oltman, Raskin & Karp, 1971). As in previous studies, students who fall "at or above the third quartile" will be designated as field independent. Field dependents are those "whose scores on the GEFT fall at or below the point that represents the first quartile." The reliability of this test is .82 for both males and females (Canino, 1988 and Whyte, 1990).

Overview of Field Independence/Field Dependence

According to Rasinski (1983), field independence/field dependence is "by far" the most researched of all cognitive styles. Most research in this area began in the early 1950's and 1960's (Witkin, Lewis, Hertzman, Machover, Bretnall Meissner & Wapner, 1954 and Karp, 1963). Herman A. Witkin, Donald R. Goodenough and Philip K. Oltman have produced most of the substantive research in this area in the last 30 years (Bertini, Pizzamiglio, & Wapner, 1986 and Witkin & Goodenough, 1981). Goodenough (1976) defines field independent individuals known as analytic or articulate, and field dependent individuals known as global.

According to Willard (1985), this dimension is concerned with an individual's ability to "perceive a part of a stimulus as discrete from its surroundings through active and analytic as opposed to passive and global processes." It is also significant to note that the field independence/field dependence dimension is "bipolar." According to Witkin and Goodenough (1977), "each of the contrasting cognitive styles has components that are adaptive to particular situations, making the dimension value neutral."

Personality Traits of Field Independents/Dependents

In an early work, Witkin, Lewis, Hertzman, Machover, Bretnall Meissner, and Wapner (1954) described a field independent individual as almost the complete opposite of a field dependent. A field independent is analytical, independent, and can function with very little environmental support. He/she also tends to have low anxiety and a high self-image. A field dependent, on the other hand, is passive, shows a lack of initiative and has a readiness to submit to authority. Although field dependents tend to be warm and likable they generally have low self-images.

In a follow-up book, Witkin and Goodenough (1981) found that based on a field independent's personality characteristics they also tend to keep to themselves or desire to work alone. They are sometimes viewed, as a result, as inconsiderate, distant and demanding. Field dependents generally make greater use of information from other students (Willard, 1985.)

Specific Characteristics of Field Independence/Dependence

Field Independence

Canino and Cicchelli (1988) define field independent individuals as those who are capable of perceiving items as discrete from background or field. They also learn better when they are allowed to develop their own strategies in problem-solving nonsocial domains. As part of their extensive research, Witkin and Goodenough (1977) stated that field independents: prefer solitary activities; are individualistic; are cold and distant in relations with others; are aloof; never feel like embracing the whole worl; are not interested in humanitarian activities; value cognitive pursuits; are concerned with philosopical problems; are task oriented; have work oriented values such as efficiency, control, competence, and excelling.

Extensive amounts of research which delineate various attributes of field independent individuals have been compiled (Goodenough, 1976; Guerrieri, 1978; Malancon & Thompson, 1990; Mikos, 1980). The following is a compilation of pertinent research:

1. Field independent (FI) elementary students gain conservation ability more quickly than FD counterparts (Wicker, 1980).
2. FI's seem to be able to learn concepts more efficiently (Stasz, Shavelson, Cox, & Moore, 1976).
3. FI's have better reading comprehension skills (Pitts & Thompson, 1984; Rasinski, 1983; and Spiro & Tirre, 1979).
4. It was reported that high scores on Witkin's tests (i.e., FI) indicate high spacial and artistic abilities (Mayo & Bell, 1972).
5. FI's tend to favor analytical professions (e.g., experimental psychology, mathematics, surgical nursing) (Rosenberg, Mintz & Clark, 1977).
6. A significant number of engineers are field independent (Barrett & Thornton, 1967).
7. FI's are likely to make the following vocational choices: science and industrial arts teachers; and production managers (Witkin, Moore, Oltman, Goodenough, Friedman, Owen & Raskin, 1977).
8. Field independence is linked to academic achievement (e.g., passing the GED exam) (Donnarumma, Cox & Beder, 1980).

Field Dependence

Field dependent individuals are almost complete opposites of their counterparts. Canino and Cicchelli (1988) define field dependent learners as those who are not as able to separate "elements from their surroundings." They experience their environment more globally and usually accept the organization provided by the "perceptual field." FDs also prefer to interact with a teacher and tend to learn better with structure. Witkin and Goodenough (1977) stated that field dependents: like being with others, are sociable, are gregarious, are affiliation oriented, are socially outgoing, prefer interpersonal and group to intrapersonal circumstances, seek relations with others and show need for friendships, show participativeness, are interested in people and want to help others, and now many people and are known to many people.

As stated above, extensive research has been compiled which delineates various attributes of the field dependent dimension (Goodenough, 1976; Guerrieri, 1978; Malancon & Thompson, 1990; and Mikos, 1980). The following is a compilation of pertinent research:

1. Field dependents show a much greater preference for working physically closer to others than FIs (Witkin & Goodenough, 1977).
2. Field dependent people also not only prefer more to be with people but also tend to be more popular with peers (Malancon & Thompson (1990.)
3. FDs tend to favor the vocational choices of social studies and elementary school teachers (Witkin, Moore, Oltman, Goodenough, Friedman, Owen & Raskin, 1977).
4. Field dependents are also attracted to "interpersonal" occupations (e.g., social work, psychiatric nursing and clinical psychology) (Rosenberg, Mintz & Clark, 1977).

GESTALT COMPLETION TEST

The Gestalt Completion Test measures cognitive flexibility and is one of 72 factor-referenced cognitive tests provided by the Education Testing Service and a part of the Kit of Factor-Referenced Cognitive Tests (1976). This test specifically measures the speed of closure which is defined as *the ability to write an apparently disparate perceptual field into a single concept* (Ekstrom, French, Harman and Dermen, 1976). These same authors identified that, "According to Carroll (1974), speed of closure 'requires a search of a long-term memory visual-representatinal memory store for a match for a partially degraded stimulus cue.' Strategies employed may include utilizing hypotheses from association in long-term memory or restructuring the stimulus perception." This test requires the participant to discern individual pieces of a whole and identify the whole figure or picture. There are no clues provided as to what the complex figure may be. No context is provided for reference to environment or cognitive situation. The test is comprised of two samples to familiarize participants with expectations. The remainder of the test is divided into two sections, each with ten boxes containing incomplete black and white pictures. Participants are asked to identify the objects within the boxes using only their imaginations. There are two minutes allowed to complete each section. Scores run on a continuum from 1 through 20 with 1 representing the highly constricted learner and 20 representing the highly flexible learner.

As identified by two independent testing sources provided in the Kit of Factor-Referenced Cognitive Tests (1976), the reliability of the Gestalt Completion test among college aged participants varies from .85 to .82. This high level of reliability led to our selection of this cognitive test for inclusion is this study.

Overview of Cognitive Flexibility

Cognitive flexibility has been studied very little in comparison to Field Independence/dependence or Kolb's Learning Style Inventory. We determined, however, that because of its supposed relationship to FI/FD that it must be included to determine a clearer picture of the cognitive style of the typical Air Force Officer. Characteristics of this style imply different abilities and approaches to problem solving than does FI/FD. Cognitive Flexibility as identified by Jonassen and Grabowski (1993), "..is a measure of the ability to ignore distractions in order to focus on relevant stimuli (Klein, 1954).."

The identification of cognitive flexibility stems from clinical research accomplished primarily by Gardner and Klein and secondarily by some of their colleagues at the Menninger Clinic. They were primarily researching the concept of how cognitive structures modulate and control human drives. The distinct difference in their research was directed toward the element that personality plays in determining cognitive roles. This element was defined by Klein as cognitive style, which also contains the components of emotion, motivation and affective elements (Ludwig & Lazarius, 1983).

Specific Characteristics of Cognitive Flexibilty

Flexibility

Flexible processors, according to Jonassen and Grabowski (1993), are: focused, analytical, open to change, use feelings and other emotions, use internal cues as information sources, use all available external cues.

Constricted

Constricted processors according to the same sources display characteristics opposite to those of Flexible individuals. Those characteristics are described as: distracted, global, resistant to change, avoid feelings or emotion, use reaction as information sources, over generalize cognitive set cues.

Recent research involving cognitive flexibility is looking at Hypermedia and the application of knowledge in new situations, comprehension, problem solving, and decision making. Findings in these studies, however, are not yet generalizable to this study. Reference research will continue to be made to identify any computer skill attributions and related findings concerning this cognitive style which may impact future implications.

KOLB LEARNING STYLES INVENTORY II '85 (LSI 1985)

Kolb's Learning Style Inventory II '85 is a tool recognized in the education community for the measurement of an individual's intrinsic learning style or individuals predisposition in any given learning situation. It was developed according to the theory of learning expressed in the Experiential Learning Model (ELM) (Kolb, 1974; Kolb, 1976; Kolb, Rubin and McIntyre, 1974). It was designed to be utilized specifically with an adult population in education or employment settings. In 1985 the Learning Style Inventory underwent a revision intended by David A. Kolb as "improvements designed to enhance the scientific measurement specifications and the inventory's practical uses in education and counseling" (Technical Specifications, 1985). The LSI 1985 is a set of 12 completion statements with 4 rank ordered endings requiring approximately 10 minutes to complete and another 5 to 10 minutes to self-score.

Reliability and Validity

Technical Specifications (1985) reports very good internal consistency coefficients as measured by Cronbach's *a* coeffiecients (ranging from .82 for Concrete Experience (CE) and .83 for Abstract Conceptualization (AC) to .78 for Active Experimentation (AE) and .73 for both Reflective Observation (RO). Tukey's test measured an almost perfect additivity of 1.0 (Technical Specification, 1985.) Similar data on internal consistencies or reliabilities were reiterated in subsequent studies by Sims, Veres III, Watson, and Buckner (1986) Sims, Veres III, and Shake (1989).

Validity is reflected in the intercorrelations among the mode of lerning style and difference scores on the (AC-CE) and (AE-RO) bipolar dimensions. As expected, these intercorrelations are in the negative direction although they vary greatly in magnitude. the ranges were reported from -.05 to -.85 with an absolute value mean of .36.

These findings are substantiated by Cornwell and Manfredo (1994). Their findings tended to support Kolb's generalizations about the relationship of any two learning orientations to a respective learning style.

1. (AE) "doing" and (CE) "feeling" to Accomodators
2. (RO) "watching" and (CE) "feeling" to Divergers
3. (RO) "watching" and (AC) "thinking to Assimilators
4. (AE) "doing" and (AC) "thinking" to Convergers

Cornwell et al. described a "functional relationship existing between the two learning style typologies such that each classification of learning orientation corresponds to only two classifications of the learining typology. As an example, primary learning style (PLS) "feeling" corresponds to learning style type (LST) diverger or accommodator. Similarly, LST accommodator corresponds to PLS "feeling" and "doing" (1994).

David A. Kolb defines learning styles as an individual's self-diagnosed, preferences in the perception and subsequent processing of information (Kolb, 1984; Jonassen & Grabowski, 1993). Crossing the perceptual bi-polar continuum of concrete experience (CE) versus abstract conceptualization (AC) with the information transformational bi-polar continuum of reflective observation (RO) and active experiementation (AE) differentiates four types of learning styles.

1. ***Divergers*** experience their environment concretely through their feelings related to the tangible here and now (CE) and transform it through internal reflection or thought (RO)
2. ***Assimilators*** experience their world symbolically through abstract conceptualization (AC) and transform it through thought (RO) as the Divergers.
3. ***Convergers*** perceive their environment through analytic thought or abstract conceptualization (AC) and transform that information through action (AE)
4. ***Accomodators*** grasp their environment concretely through their feelings (CE) and also utilize action or actively manipulate their environment (AE) to transform these experiences or information (Jonassen & Grabowski, 1993; Krahe, 1993)

Heredity, previous formal or informal socialization and education experiences, as well as the immediate environment play a large part in the tendency of an individual to favor some learning abilities over others.

Specific Characteristics of Kolb's Learning Styles

Jonassen and Grabowski (1993) described some general strengths and weaknesses associated with each of the four learning styles reflecting the bi-polar nature of the dimension reflecting the individual's perception of information in addition to how that individual transforms or processes that information.

Divergers

Divergers have the ability to assimilate or synthesize a wide-range of disparately different observations into a comprehensive explanation. This enables them to generate many ideas. they are intuitive, imaginative, have many broad cultural interest, and are able to perceive many divergent viewpoints. their people-oriented skills enable them to relate well to others. On the downside, Divergers are "less concerned with theories or generalizations" (p.250). they approach situations in a less thoughtful, systematic or scientific way. This inhibits their ability to make decisions.

Assimilators

Assimilators take a focused, systematic and scientific approach to their environment. This use of logic, inductive reasoning skills, and the ability to view multiple perspectives is needed to theoretically model building. This is reflected in their ability to organize information well which is needed in the design of stable experiments. Assimilators prefer analytic, abstract, and quantitative task and, conversely, feel uncomfortable performing qualitative or concrete tasks. They focus less on interpersonal, people oriented skills which reduces their ability to impact or influence others. Because they are less action oriented, they are less able to apply theories and model to the real world.

Convergers

Convergers bring a logical, pragmatic, as well as focused and unemotional perspective to any situation. They have the ability to problem solve, make thoughtful decisions, and get the job done, many times, creating new ways of thinking and doing when the situation needs it. Their focus on the analytical reduces the intuitive understanding necessary in relation to people skills and increases their discomfort concerning social or interpersonal issues. They are sometimes considered non-artistic, unimaginative and closed minded which can tend toward a narrow range of interests. They are uncomfortable with the qualitative or the concrete. They are more concerned with the "relative" truths than absolute truths.

Accomodators

Accomodators prefer to carry out plans which produce action and results based on facts and reality. They are risk takers and enjoy seeking out new experiences. This enables them to adapt to new situations and environments well. Their op-minded, intuitive, people oriented approach enables them to influence and lead others or impact a situation because of their personal involvement. Because they rely more heavily on other people for information, they are less scientific, systematic, and analytical in their approach to a given situation. they tend to favor a trial-and-error approach to their environment disregarding theory. They are sometimes perceived as impatient and controlling. Like the converger, they are less concerned with absolute truth the "relative" truth.

RESULTS/DATA ANALYSIS

RESULTS

The total sample size equaled 107; 77 cadets, 30 officers. Following are percentage breakdowns of the total population for gender, nationality, ethnic group, undergraduate major and number of courses in computer science.

Gender:	85% male
	15% female
Nationality:	94.4% American
	1.9% Other
	3.7% Not reported
Ethnic Group:	5.6% African American
	5.6% Asian
	1.9% American Indian
	1.9% Hispanic
	81.3% Caucasian
	3.7% Not reported

Undergraduate Major:

2.8% Behavioral Science
7.5% Biology
12.1% Business/Management
9.3% Computer Science
.9% Economics
35.5% Engineering
10.3% Geography
4.7% History
.9% Languages
2.8% Math
2.8% Physics
9.3% Political Science
10.3% Other

Computer Science Crs:

1.9% No courses
64.5% 1-2 courses
17.8% 3-4 courses
5.6% 5-6 courses
5.6% 7-8 courses
1.9% 9-10 courses
2.8% 11+ courses

These statistics identify that this sample population mirrors the Air Force of today by gender. It is representative of a primarily American population with diverse ethnicity. Fields of undergraduate study range over more than twelve different subject areas, identifying multiple interests and expertise throughout the group. Finally, these statistics identify that this population is familiar with computers and operations of computers in their lives with 98.1% having taken a minimum of 1+ courses in computer science.

CADET POPULATION

The cadet population closely mimics the population sample as a whole. The percentages are only slightly different but emphasize the same representative population over all. Following are the specifics:

Gender:

90.9% male
9.1% female

Nationality:

97.4% American
2.6% Other

Ethnic Group:

5.2% African American
6.5% Asian
2.6% American Indian
2.6% Hispanic
83.1% Caucasian

Undergraduate Major:

2.6% Behavioral Science
5.2% Biology
15.6% Business/Management
9.1% Computer Science
1.3% Economics
40.3% Engineering
5.2% History
2.6% Math
6.5% Political Science
11.7% Other

Computer Science Crs:	74.0% 1-2 courses
	13.0% 3-4 courses
	5.2% 5-6 courses
	6.5% 7-8 courses
	1.3% 9-10 courses

The only identifiable differences between the cadet population and whole sample were in undergraduate major, where Physics, Language and Geography were not identified as a major area of study. Additionally, no students had taken above 11 computer science courses. These differences are not considered by the researchers to be significant since the percentages in the main populations for these features were minute.

Consistency with the total population is significant. Gender representation for cadets was 10% female, which is in direct correlation with the Air Force as a whole. 97.2% are American, with primarily a Caucasian ethnicity, but with representation from multiple groups. Undergraduate major had the largest percentage in Engineering, but a representation at some fairly high levels appeared in 9+ major areas indicating diverse interests and expertise. All cadets have had at least one to two courses in computer science.

Officer Population

Following are the statistics for the officer population in comparison to the total sample.

Gender:	70% male
	30% female
Nationality:	86.7% American
	13.3% Not reported
Ethnic Group:	6.7% African American
	3.3% Asian
	76.7% Caucasian
	13.3% Not reported
Undergraduate Major:	3.3% Behavioral Science
	13.3% Biology
	3.3% Business/Management
	10.0% Computer Science
	23.3% Engineering
	3.3% Geography
	3.3% History
	3.3% Languages
	3.3% Math
	10.0% Physics
	16.7% Political Science
	6.7% Other
Computer Science Crs:	6.7% No courses
	40.0% 1-2 courses
	30.0% 3-4 courses
	6.7% 5-6 courses
	3.3% 7-8 courses
	3.3% 9-10 courses
	10.0% 11+ courses

These, again, correlate very highly with the percentages of the total sample. The officers had more computer science courses than the sample or the cadets. Officers had a higher population of females who participated. The ethnic diversity was not as broad, but still represented more than one ethnic group.

In addition to the identified categories for the cadets and the whole sample, the following data was collected specifically for officers. This was to identify who the members of this group were in relation to the total Air Force population.

AFSC	6.7% Acquisition/Contracting
	3.3% Air Defense
	3.3% Civil Engineering
	10.0% Communication
	6.7% Engineering
	3.3% Intelligence
	3.3% Missiles
	10.0% Navigator/Weapons Systems
	20.0% Pilot
	6.7% Space Operations
	6.7% Other
	20.0% Not identified
COMMISSIONING SOURCE	20.0% AFROTC
	16.7% OTS
	43.3% USAFA
GRADUATE MAJORS	3.3% Behavioral Science
	10.0% Biology
	3.3% Business/Management
	13.3% Computer Science
	6.7% Education
	20.0% Engineering
	3.3% Geography
	3.3% Languages
	10.0% Physics
	13.3% Political Science
	13.3% Other
PROFESSIONAL MILITARY EDUCATION	33.3% SOS
	36.7% Intermediate Service School
	10.0% Senior Service School
RANK	6.7% O-3
	56.7% O-4
	36.7% O-5

This data indicates that the participating population does represent the Air Force of today. Eleven+ AFSCs are represented, with officers from all commissioning sources. Graduate majors are as varied as the undergraduate majors. A slightly larger Majors participation than Lt. Colonel which coincides with actual numbers of officers in the Air Force at those levels today.

Because of the congruence between cadets and officers in comparing all collected data, including the learning styles results, we will only identify the findings from this point forward for the group as a whole.

Following are the results for each individual cognitive style tested for with the participants. The results stand alone and reflect scoring of the tests based upon requirements of each testing mechanism.

FI/FD

FIELD DEPENDENCE/INDEPENDENCE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
FI	1	92	86.0	86.0	86.0
>FI	2	7	6.5	6.5	92.5
>FD	3	2	1.9	1.9	94.4
FD	4	6	5.6	5.6	100.0
			-------	-------	-------
Total			107.0	100.0	100.0

Figure 2

As the chart (figure 1) above illustrates this population is 86.9 extremely field independent. The combination of FI and >FI make up 92.5% of the population with only 7.5% of the total population being a combination of FD and >FD, identifying a clear tendency for Field Independence.

COGNITIVE FLEXIBILITY

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Extreme Flexible	1	53	49.5	49.5	49.5
Flexible	2	51	47.7	47.7	97.2
Constricted	3	3	2.8	2.8	100.0
			-------	-------	-------
Total			107.0	100.0	100.0

Figure 3

Since the tendency for cognitive flexibility is expressed along a continuum from 0 to 20, this team of researchers divided the continuum into four quartiles:

0-5 = extremely constricted
6-10 = constricted
11-15 = flexible
16-20 = extremely flexible

These quartile identifiers allowed us to determine to what extent this population is cognitively flexible or constricted. The chart above clearly demonstrates that our participants are 97.2% cognitive flexible, with an approximate 50-50 split between extremely flexible and flexible. Only three participants out of 107 tested constricted with 0 testing extremely constricted.

KOLB LEARNING STYLE INVENTORY					
Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Diverger	1	15	14.0	14.0	14.0
Assimilator	2	26	24.3	24.3	38.3
Converger	3	50	46.7	46.7	85.0
Accomodator	4	16	15.0	15.0	100.0
			-------	-------	-------
Total			107	100.0	100.0

Figure 4

As reflected in this chart 46.7% of the participants tested out as Convergers with the next largest population being Assimilators at 24.3%.

Comparison of Test Materials

As a further demonstration of the statistics, following are three charts; one comparing Cognitive Flexibility and FI/FD, two comparing Kolb Learning Style and FI/FD, and the third comparing Kolb Learning Style and Cognitive Flexibility. A Chi-square has been run with these cross tabs to determine any levels of significant.

COGNITIVE FLEXIBILITY VS FIELD DEPENDENCE/INDEPENDENCE

	FLEXIBILITY					
	Count	Extreme Flexible 1	Flexible 2	Constricted 3	Row Total	%
FI/FD						
FI	1	47	43	3	93	86.9
>FI	2	2	4		6	5.6
>FD	3	2			2	1.9
FD	4	2	4		6	5.6
	Column Total	53 49.5	51 47.7	3 2.8	107	100.0

Chi-Square	Value	DF	Significance
Pearson	4.03688	6	.67168
Likelihood Ratio	5.12545	6	.52783

Figure 5

KOLB LEARNING STYLE VS FIELD DEPENDENCE/INDEPENDENCE

FI/FD	Count	KOLB LRN STYLE Diverger 1	Assimilator 2	Converger 3	Accomodator 4	Row Total	%
FI	1	12	25	43	13	93	86.9
>FI	2			5	1	6	5.6
>FD	3	1			1	2	1.9
FD	4	2	1	2	1	6	5.6
	Column Total	15 14.0	26 24.3	50 46.7	16 15.0	107	100.0

Chi-Square	Value	DF	Significance
Pearson	11.32612	9	.25402
Likelihood Ratio	12.93238	9	.16569

Figure 6

KOLB LEARNING STYLE VS COGNITIVE FLEXIBILITY

KOLB LRN STYLE

FLEXIBILITY	Count	Diverger 1	Assimilator 2	Converger 3	Accomodator 4	Row Total	%
Extreme Flexible	1	9	10	23	11	53	49.5
Flexible	2	6	15	25	5	51	47.7
Constricted	3		1	2		3	2.8
	Column Total	15 14.0	26 24.3	50 46.7	16 15.0	107	100.0

Chi-Square	Value	DF	Significance
Pearson	5.21428	6	.51664
Likelihood Ratio	6.05043	6	.41757

Figure 7

The Air Force Officer of Today and Tomorrow

Based upon the data collected we have determined:

1. The Air Force Officer of today and tomorrow vary little in their statistical makeup.
2. They are field independent, cognitively flexible and convergers. These three styles have common characteristics, independently defined, as supported by the literature. Common characteristics of these three styles include

- Analytical, logical, pragmatic
- Concern for ideas and principles
- Prefer solitary activities, individualistic
- Focused, unemotional perspective to situations
- Self motivated, favor lectures in learning
- Have excellent reading comprehension skills
- Superior problem solvers, adapting the approach to the problem
- Do not require externally provided structure
- Open to change
- Creates new ways of thinking and doing when the situation requires
- Work oriented values such as efficiency, control competence, and excelling
- Considered non-artistic
- Select scientific, experimental psychology, mathematics, and engineering careers
- Efficient at restructuring and organizing visual/spatial information
- Adept at processing unusually complex visual materials

DISCUSSION/IMPLICATIONS

Based upon this initial research, it appears that it may be possible to identify a multidimensional construct for individuals. These researchers believe that if two multidimensional constructs which were bipolar could be identified, instruction could then be adapted to meet the needs of students more specifically. With the extremes identified, the needs of the individuals leaning in either direction would also be met. While we believe this baseline study provides a "first look" at previously undocumented information about comparison of three learning styles inventories, the door to what this means has only been slightly opened.

Future studies should include a larger population of individuals from public university settings. While this group was highly representative in many areas, it did not represent a normal population spread for gender or nationality. It would be important to test students at international universites to see if a this construct could be generalized to a larger population.

Only three tests were used in this baseline study. We must expand the number of cognitive tests used to provide a more extensive picture of this multidimensional construct. Styles such as visual/verbalizer, locus of control, impulsivity/reflectivity, and cognitive width would provide a more in-depth picture of our population.

We must look at development of a test environment which mimics the real world to see how individuals approach problem solving and decision making. We should track such items as cognitive strategy and time on task, which could identify ability to perform in stressful situations.

Clearly, much research is still needed. This study only takes a beginning look at the implications of cognition and a multidimensional construct. Future study can only enhance this look and provide necessary, vital approaches to instructional design and delivery.

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Title:

Dynamic Learning Communities: An Alternative to Designed Instructional Systems

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In the wake of the constructivist movement in psychology and education, the field of instructional design (ID) is reexamining its relationship to learning and instruction. Many ID theorists are calling for more situated approaches to the design of instruction, encouraging teachers and local groups to take ownership of the design process and adapt their methods and goals to the needs of students and stakeholders (e.g., Wilson, Teslow, and Osman-Jouchoux, 1995). Others have defended traditional views of instructional design as a prescriptive science, charged with developing universal methods and strategies that will result in effective, efficient instruction (Merrill, Drake, Lacy, & Pratt, 1996).

The problem is exacerbated by the growing negative connotation of 'instruction.' To many constructivist educators, what they are trying to accomplish with students cannot be captured by 'instruction.' Instruction is typically thought to have clear, prespecified learning objectives, teacher-determined activities and instructional strategies, and clear boundaries in time and space. What happens when learning happens, but not in such clearly directed, controlled terms? ID theorists are examining alternate metaphors such as "learning environments" to understand and describe learning where the learner assumes more direction and control over goals, content, and methods (e.g., Wilson, 1996).

The idea of "learning communities" has also been discussed as an alternative metaphor to traditional instruction. What happens when groups of people gather together to provide mutual support for learning and performance? How would that work? Rather than being controlled by a teacher or an instructional designer, learners might "self-organize" into functioning communities with a general goal of supporting each other in their learning. That is to say, the function of guidance and control becomes distributed among group participants. Specific roles of group members are not assigned but rather emerge from the interaction of the whole.

This paper is our initial effort to outline the concept of a dynamic learning community as an alternative to teacher-controlled or pre-designed instructional systems. We argue that dynamic learning communities constitute an important alternative to specifically designed instructional systems, and that communication technologies can serve to support learning communities in their efforts. We present below an outline of our current thinking. For future papers, we intend to gather more examples or case reports concerning specific learning communities.

WHAT IS A DYNAMIC LEARNING COMMUNITY?

Our definition for DLCs is offered in Table 1. We see DLCs as decentralized groups focused and interacting enough to form a stable community. Let us first unpack the elements of the term:

Communities. Groups become communities when they interact with each other and stay together long enough to form a set of habits and conventions, and when they come to depend upon each other for the accomplishment of certain ends.

Learning communities. In truth, all communities learn. One of the lessons of postmodernism and situated cognition is that learning cannot be separated from action. We are learning every day, in everything we do. We add the qualifying term to our definition to suggest a community sharing a consensual goal to support each other in learning. Everybody expects to learn and is prepared to engage in activities at least partly for that reason. This would distinguish learning communities from those solely concerned with entertainment, political action, or the performance of an immediate task. We would note, however, that groups can have complex agendas, and that a group may have multiple goals that are commonly shared throughout the membership, such as supporting both work performance and learning among its members.

Dynamic learning communities. The term 'dynamic' is added to distinguish the construct from traditional, centralized groups of learners found in many classrooms. In a dynamic community, all members share control, and everyone learns, including the "teacher" or group leader (cf. Wilson & Cole, 1997; Scardamalia & Bereiter, 1994). Transformative communication is the norm, wit both sender and receiver of messages changed by the interaction (Pea, 1994). Thus a classroom wherein the teacher assigns a project, expecting the students to learn something but not expecting herself to learn—such a classroom would not yet be a dynamic learning community because all participants are not engaged in the learning experience.

Dynamic learning communities (DLCs) are groups of people who form a learning community generally characterized by the following:
—distributed control;
—commitment to the generation and sharing of new knowledge;
—flexible and negotiated learning activities;
—autonomous community members;
—high levels of dialogue, interaction, and collaboration;

—a shared goal, problem, or project that brings a common focus and incentive to work together.

We would expected to see the following additional characteristics over time:

POSITIVE OUTCOMES
—capacity to adapt to local conditions and evolve over time;
—creativity and innovation;
—crossing of traditional disciplinary and conceptual boundaries;
—appreciation of diversity, multiple perspectives and epistemic issues;
—community members who are responsible and skilled at diagnosing and addressing their learning needs;

NEGATIVE OUTCOMES
—occasional inefficiencies;
—lack of control;
—lack of predictability.

Table 1. Definition and characteristics of dynamic learning communities (DLCs).

DLCs are the sort of open, adaptive system described by Kevin Kelly in his book *Out of Control* (Kelly, 1994). Open systems are defined by "(1) the absence of imposed centralized control; (2) the autonomous nature of subunits; (3) the high connectivity between the subunits, and (4) the webby nonlinear causality of peers influencing peers" (Kelly 1994, p. 22, reformatted).

According to complexity theorists (see also Gleick, 1987; Hayles, 1991; Prigogine & Stengers, 1984; Waldrop, 1992), a complex, adaptive system takes on life-life qualities such as intelligence, intentionality, self-correctability, and self-preservation. Examples of complex systems include the stock market, ecological systems, and living organisms. Similar qualities of intentionality and adaptivity should emerge in a learning community if they have the characteristics noted in Table 1 and further discussed below.

Distributed control. In a typical classroom, the teacher is in charge. The teacher makes all the important decisions, such as what to teach and how to teach it. In a DLC, nobody is in control—everybody is! Conventions, shared understandings, rules for settling disputes or for governing communications—All of these are negotiated and agreed upon by the group as a whole. So are learning goals and methods. If one member has a different vision for where the group should be going, this is presented to the group and discussed. The community is bigger than any single member, yet it encompasses the perspectives of all members.

Commitment to the generation and sharing of new knowledge. Everybody learns. Nobody stands apart, pulling the strings for the sake of the others. By sharing, listening, imitating, and watching, all members of the learning community benefit. Those with greater expertise play critical roles in helping and modeling, yet they are expected to learn, solve problems, find answers, right along with the rest of the group.

Flexible and negotiated learning activities. Specific learning goals and activities largely "happen." There is a sort of natural selection of activities—Those that are successful and lead to learning are repeated and developed and shared, while those that are not supported by the group fall into disuse. This can lead to inefficiencies and a meandering process of development, but it can work.

Autonomous community members. One of Kelly's key components of complex systems is that of "autonomous agents"; that is, community members must have a certain room to direct their own activities and make decisions. There needs to be room for variation and differences among community members; otherwise the system devolves down to a single controlled perspective.

High levels of dialogue, interaction, and collaboration. High levels of connectivity are essential to complex systems and to DLCs in particular. A neighbor may be doing great things, but if that information is not shared via constant communication, then other community members will not be aware of it. Information is what drives the feedback loops that lead to new learning and change in the overall system.

A common focus and incentive to work together. DLCs need a reason to exist. This may come from shared interests, or a common goal, problem, or project. Outside constraints, such as market or job demands, may provide an incentive for a group to form. Work groups may be motivated to keep their jobs. The free market of Internet listservs may allow communities to coalesce around very localized interests, such as breeding border collies or following the fortunes of an NFL franchise. Public-school students may converge on a project or major assignment, such as a yearbook or newspaper. Students in Carnegie-type classrooms may be hard-pressed to find a threshold of common purpose sufficient to create a truly dynamic learning community. Certainly such a concept competes with the bulk of school conventions and cultural forms.

Consistent with other complex systems, we would expect to see a number of additional features emerge in DLCs, some positive and some negative. These are briefly discussed below.

POSITIVES

Capacity to adapt to local conditions and evolve over time. Because DLCs depend upon each member for information, DLCs should be able to pick up on changes in the environment more quickly than controlled instructional groups. Behavior of DLCs are more fluidly defined and more flexible than fixed-goal and fixed-strategy systems, allowing easier adaptation and change over time.

Creativity and innovation. DLCs will tend to be more pluralistic than instructional systems because behavior is not centrally controlled. Much variant behavior may prove unfruitful, but in amid the diversity, some ideas will show promise. Thus creativity, change, and innovation should be more prevalent than in instructional systems. The DLC may experience more failures, but more innovative successes as well.

Crossing of traditional disciplinary and conceptual boundaries. Typically, a DLC cares less about its disciplinary base than the problem it is trying to solve.[14] Workers from a variety of backgrounds, for example, may form a DLC if they face a common challenge or problem. Each person brings the baggage of their prior experience, and each submits to being influenced by the community. The cross-fertilization that results can lead to new categories and new perspectives not previously perceived by established communities.

Appreciation of diversity, multiple perspectives, and epistemic issues. Expertise is inherently multi-perspectival in a DLC. Members come to respect knowledge that comes from a variety of sources—people of different backgrounds and information of different types. Likewise, community members develop their own methods for testing proposed knowledge against a variety of standards and codifying that knowledge in a way that can be shared throughout the group and across situations and time. The upshot of this diverse environment is that community members progress in their epistemic understanding, perhaps moving from black-and-white views of knowledge toward more sophisticated views of how we come to know things.

Community members who are responsible and skilled at diagnosing and addressing their learning needs. Here is both a benefit and a challenge to DLCs. When control is distributed throughout the group, more demands are placed on individual members. Because teacher is no longer doing the hard work of deciding on goals, methods, and new knowledge, community members must meet the challenge of assuming these roles. Metacognitive knowledge—knowing how to monitor one's learning and how to address ill-defined problems—becomes an essential part of the community, which hopefully can also be shared throughout the group. A systemic analysis may conclude that a given group cannot become a DLC because of deficiencies in this area. On the other hand, a group may progress incrementally in these skills and move steadily toward more self- (or community-) directed learning.

NEGATIVES

Short-term inefficiencies. Just as a Vermont town meeting can be more laborious and inefficient than a professionally managed city's well-defined processes, so DLCs can be more inefficient and indirect than controlled instruction. A well-packaged instructional program may be able to teach a fixed set of rules more efficiently. If such a product were reliably available, then a DLC would be wise to recommend its use. In the absence of such structure, however, DLCs may tend to "muddle through" (cf. Bateson, 1972, pp. 3–8) with its share of redundancies, inefficiencies, lack of focus, and lengthy processes.

In the long term, however, DLCs may be an efficient route toward learning. A cow does not look for the shortest route up a hill, but rather keeps its head down and looks for a steady way up without noticeable climbing. The result is the most efficient use of its energy (Allen, 1996). DLCs will tend to meander. But like the cow up the hill, the shortest path may not always be the wisest path, and certainly not the most efficient path.

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[14] Note our attribution of intentionality to the DLC (it "wants" this or "seeks" that). This issue is somewhat controversial; for example, Bateson (1972) avoids such language because it leads to a category error—thinking that systems have a mind in the same way humans do. Part of our message, however, is that complex systems *do* seem to have minds of their own; that is, they come to behave as though they had intentions. Whether this crosses a boundary of appropriate discourse, and moves into an anthropomorphic error, we will speak of systems as having intentionality because it is a useful shorthand for understanding complex systemic behavior.

Lack of control. DLC's decentralized control can be a handicap. The leadership and vision of a charismatic leader can marshal community resources and stimulate purposive action. At times, the unwieldiness or fuzziness of a DLC can frustrate those who would like to see decisive action or clear direction for learning.

Lack of predictability. DLCs can frustrate the intentions of the best designers. A constant among initiators of DLCs is the reported surprise at the direction the group takes. DLCs seem to have a mind of their own, and where they end up is not where they start. This is true of distance-learning groups, workgroups, and learning communities within classrooms. Often the surprises are pleasant, but the evolving nature of the group can be difficult for people trying to plan for the future.

In one sense, DLCs can be thought of as being learner-centered. Community members must take more responsibility for their own learning than in most designed instructional systems. In another sense, however, the "centeredness" is found in the community rather than the individual learner. Ideally, community members lacking metacognitive skills may participate and receive support from the group. The group often dictates the learning agenda—or at least engages individuals in dialogue concerning that agenda. The thought of individuals isolated, setting individual goals, pursuing those learning goals individually—This is contrary to our conception of a dynamic learning community. So we tend to think of DLCs not simply as tools for self-directed learning, but as supportive communities wherein a variety of learning goals may be pursued, some individual and some shared throughout the membership.

THREE SCENARIOS

In this section, we present three scenarios we have observed, where dynamic learning communities (or DLCs) are beginning to take root.

Workplace learning. Martin works with a group of engineers charged with developing new products and specifications for supporting those new products. Martin finds himself working on products whose standards have not yet been finalized, which in any case will be replaced within 18 months by another standard or a newer, more capable product. When a standard doesn't exist, where does an engineer go to get answers? Off-the-shelf training is no help except for generic skills. Customized training products such as computer-based training take too long too develop and would not be cost-effective for the specialized needs of the small engineering workgroup. Hiring a consultant/trainer to come from the university and give lectures is a possibility, but often the expertise is not available, and when it is, the costs of pulling people away from their work in a high-pressure environment can be enormous. Even traditional performance support systems—electronic or otherwise—exact a toll in time and effort. These systems must be designed, and therein lies the problem: nobody knows enough to design them, and if they did, they would be too busy putting out immediate fires to take the time. In short, expertise is scarce and doesn't exist in any form specifically designed for instruction or support.

As an alternative to traditional training and performance-support solutions, Martin has been promoting the concept of shared problem solving and archiving of solutions. When an engineer needs help, she asks for help among the workgroup. If someone has an answer, the solution is shared publicly and archived for future reference. Getting engineers to think in terms of mutual, collaborative support is a challenge, but given the pace of change and the demands for expertise, they really have no choice. They must learn to share expertise, or they will not survive in their competitive environment. This general approach of mutual support for learning is further discussed in later sections of the paper.

Academic culture. What is an academic program? Is a masters program the sum of courses required of students for the degree, or is it something more? How does an academic unit's local culture serve to encourage learning—within classes, on collaborative projects, or among individual students and faculty? Brent has been reflecting on ways that students, faculty, staff, friends, and alumni all work together to foster learning and professional growth. The communications infrastructure provided by e-mail and the World-Wide Web can serve to facilitate higher levels of connectivity and participation and new learning.

In the case of higher education, faculty members benefit as much as students from the interaction and sharing of expertise. Because faculty members do not typically return to school for more degrees, they rely on professional interactions—including stimulus from students—as a key resource for new learning.

For the last couple of years, Brent and colleagues have been exploring ways to strengthen the collaborative sharing and out-of-class learning that naturally occurs in and around the academic program (see Wilson, Ryder, McCahan, & Sherry, 1996 for a report of their work). Students with resources of their own become less dependent on professors and courses as sources of expertise, and move toward a wider variety of learning activities and interactions. Over time, these informal interactions come to constitute a learning community, and become as important to the education of participants as formal courses.

Internet discussion groups. Globally, a swell of informal or distributed learning initiatives have taken shape, using the Internet as its medium. Indeed, the Internet serves as a sort of "petri dish" wherein a variety of informal cultures have begun sprouting up. Many of these learning initiatives are independent of traditional instruction. Participants in a listserv such as IT Forum, for example, may engage in high-level discussions concerning technology in education, yet their participation may not be reflected in course credit and may not be governed by a teacher or instructional designer (Rieber, 1996). People may especially benefit from participating on global forums when expertise is rare within their local environment. In a way, the monopoly of expertise is being shaken loose from the universities, big businesses, large cities, and developed countries, and is being distributed throughout the world via the Internet. The opportunities afforded by new communications technologies will eventually have profound implications for how we think about learning and instruction.

THE DLC LEARNING PROCESS: THE DIALOGICAL CASE

Learning can happen in a variety of ways within a DLC; however, a pattern of mutually support will tend to emerge, outlined in Table 2 below. Each step is described in turn.

1. Articulate the learning need. This becomes the learning "problem" or goal.
2. Seek help in a group forum.
3. Engage in a help consultation.
4. Assess learning.
5. Share the solution with the group. Restate the problem and solution if necessary.
6. Archive the interaction or the restated solution for future reference.
7. Repeat this process, of any part, as necessary to support learning.

Table 2. A dialogical approach to learning within DLCs.

Articulate the learning need. A community member becomes aware that she or he lacks some skill or knowledge. The learning need may not be fully analyzed; that is, how the needed knowledge relates to a particular problem or performance need not be fully specified at the outset. The need to know becomes a "problem" or learning goal for the individual.

Seek help in a group forum. The community member then seeks help, often in a public forum, such as a distribution list or listserv maintained by the DLC.

Engage in a help consultation. Another community member helps or consults with the first member. Help consultations may draw on a variety of resources:

—human resources;
—archived interactions;
—FAQs;
—information search tools;
—performance supports;
—instruction.

Community members may discuss the issue at length, publicly—Or the help consultation may be simple, direct, and private.

Assess learning. Community members have a variety of tools to use in testing out new knowledge or skill. If the help consultation provides incomplete information, the community member may succeed in filling in the missing information. A recommended procedure can be tried out; if it fails and the problem can't be solved, the person goes back and reports the problem and repeats the interactive process. If new knowledge is offered, it is tested against prior knowledge and understanding. New knowledge can also be compared across members of the group. Typically, a combination of self-assessment and consensual agreement is the norm.

Share the solution with the group. After new knowledge or skill is tried out and confirmed, the solution is shared with the group. A restatement of the original problem and its solution may be helpful, especially for future reference.

Archive for future reference. Ideally, every DLC interaction should be archived for future retrieval. If an automatic archiving system is not in place, then each solved problem or significant interaction should be stored in a public location for future access by any member of the group.

Repeat as necessary. Although listed in steps, the general process is flexible. Any step or set of steps may be repeated in the process of generating solutions to learning problems.

The process above typifies interactions where a specific learning need is identified. A common alternative is the kind of informal discussion characteristics of many listservs and discussion groups. Frequently, knowledge sharing is not problem-driven but rather conversation-driven. In those cases, the learning activity is less strategic and less defined, but learning is nonetheless supported by mutual sharing and concern around a topic of interest.

Managing Expertise in the DLC

One challenge DLCs have is keeping both experts and novices happy interacting within the same group. Novices have a tendency to ask inappropriate questions and to not use the full resources available to them. Experts can feel overworked, exploited, or unchallenged—feeling that they aren't learning anything. How does a learning community deal with the varying needs of its members? Before we specifically address this question, a few general comments are in order.

Expertise is relative and multi-faceted. Expert and novice roles fluctuate within the community. Brent is an expert at one thing, Martin at another. Some members may be expert at group cohesion, serving a critical support role in keeping the community together. Others may participate irregularly, but have important input at certain junctions. Certainly labels such as "expert" or "novice" do not capture the richness of the expertise that is distributed throughout a learning community.

There must be a legitimate self-interest to sustain individual participation. At the individual level, community members must each feel a personal return on their investment in the group. In this sense, a perceived self-interest must accompany continuing involvement with the community. There are, however, a number of grounds for self-interest. Some people get tremendous satisfaction out of helping others. Some people like to think of themselves as being a source of expertise to others. Some people have a need to feel connected to groups of people, even when significant new learning happens only irregularly. Some people develop a sense of loyalty and constancy, committing time and resources to a community because it helps them find a "home." All of these may be reasons why a person with considerable expertise may choose to participate in a diverse learning community.

Martin has an example from engineering. An Internet discussion list exists around new standards for the next generation of the SCSI interface. List members have a variety of motives for participating. A sales and marketing person may feel like a novice, with a need to upgrade his understanding of technical details. An experienced engineer may participate because she feels a need to maintain a link to "people out there" and understand people's reactions to proposals and possibilities. This knowledge will then help her in establishing better standards. The list thrives because people depend upon each other and need the different kinds of expertise available among the group.

We return again to the different needs of novices and experts within learning communities. Novices often feel intimidated, or may tend to under-utilize available resources, while experts' time is often overtaxed with questions and service demands, leaving little time for the renewal of their own expertise. We offer several possible strategies that DLCs might choose to adopt in addressing the general problem, summarized in Table 3 below.

For Everyone:
- Varied levels of discussion and activity (e.g., beginners vs. advanced)
- A process that inducts beginners and moves them through increasing levels of expertise
- Moderated lists

For the Expert:
- Public and private accounts
- Allowing anonymous posts
- Private groups
- Temporary consultations, participation

For the Novice:
- User-friendly search and navigation tools
- Private consultations and re-directions
- Paid advisors/help specialists (e.g., AOL guides)
- Standard problem-solving protocols (e.g., "have you read our FAQ?")

Table 3. Possible strategies for managing expertise within dynamic learning communities.

The strategies suggested in Table 3 are possibilities only. Several would curtail or constrain free interaction within the group, thus inhibiting the "dynamic" nature of the learning community. Care should be taken not to fix a problem that doesn't exist. Specific policies can best be determined by consensus among the local community, and evolve over time as needs change.

ID VERSUS DLCs?

Both instructional design (ID) and DLCs can lead to learning. However, other things being equal, we believe that open systems are preferred because they address more fundamental learning outcomes, e.g., self-directed inquiry, learning-how-to-learn, metacognition, etc., and are more closely situated within a natural performance environment. The following table presents an outline of variables to consider when choosing between DLCs and designed instructional systems.

Use Instructional Design if these conditions apply:

- stable content over time;
- well-defined content;
- best for algorithms and rules;
- heavy representation demands;
- mastery of discrete knowledge is valued.

Try DLCs if these conditions apply:

- volatile, changing, or new content;
- ill-defined content;
- best for complex problems and content;
- heavy literacy and metacognitive demands;
- community-directed, situated support for learning is valued.

The following are relevant (but NOT determining) factors:

- level of expertise;
- criticality of content.

Table 4. Factors to consider when deciding between designed instruction and dynamic learning communities.

Note that the criticality of the learning or the advancedness of the skills are not determining factors when deciding between designed instruction and DLCs. That is, DLCs can be effectively used at varying levels of expertise, and with critically important content. Where certification of expertise is necessary, however, individuals should demonstrate their expertise using accepted assessment methods, regardless of the method of learning support.

In general, the more stable, defined, and discrete the content, the more sense to design instruction to meet the learning need. Contrariwise, the more volatile, ill-defined, and complex the learning needs, the more sense to try dynamic learning communities as a support strategy.

In the end, the decision between designed instruction and DLCs is partly one of utility and partly one of value. That is, given the same ends, DLCs may prove more or less effective in accomplishing learning. Seen in this way, the issue is one of utility. Taken the next level, however, designed instruction cannot be said to accomplish the same ends as DLCs, and vice versa. At this point, the decision necessarily rests on the question: What learning ends do we really value? Members of dynamic learning communities will come out of their experience with different skills, perspectives, and appreciations than graduates of an instructional program. These differences must be respected and considered when choosing between approaches to learning support—in addition to the utilitarian considerations mentioned above.

Costs. Traditionally designed instruction requires relatively low investment to establish the culture because most school and training cultures are already in place. However, heavy investment is required for each new instructional product and for continuing delivery of instruction. DLCs, on the other hand, require heavy front-end investment to establish a culture and support new users. Once users become experienced, the costs can be expected to be lower. At this point, we really don't know enough about cost comparisons to make definitive judgments. More data on this subject will be helpful as DLCs become more heavily used and studied.

CONTROL OF DLCs

As we made emphasized above, because DLCs are open systems, control is distributed throughout the community. This can be both a strength and a weakness. Examples of problems that can arise include:

—pornography access in a middle school;
—bomb-assembly instructions two or three links away from your homepage;[15]
—competitor "air space" on company-sponsored net;
—flaming and dissent on discussion groups;
—addictive and inappropriate behaviors;
—mismatch between DLC learning and externally-defined curriculum objectives.

Deciding how to deal with these kinds of problems brings us back to the core differences between open learning systems and closed instructional systems. We may choose to respond to problems by seeking to limit the openness of resources available to a DLC. Possible methods for exerting some measure of control over DLCs include:

—list moderation;
—control over membership;
—externally mandated rules and conventions;
—imposed problems or learning activities;
—imposed assessment standards.

Such attempts are controlling DLCs constitute a compromise of their open nature. Thus the learning community becomes something of a hybrid between a DLC and a designed instructional system. Such compromises may be necessary in schools or other real-life settings, but they should be implemented very carefully, since interventions can have unpredictable effects on group functioning. This again is another area that we know very little about, in need of further research.

CONCLUSION

Heretofore, instructional designers have thought they were in the business of designing instructional systems to meet prespecified learning objectives. But first the constructivist movement—and now communications technologies themselves—seem to be threatening this conception as the sole way to support learning. People are learning without help from designed instruction! In many settings, in fact, "natural" learning is more prevalent than "designed" learning (Resnick, 1987). We believe that the situation requires a reexaminination of our core roles. Are we in the business of designing instruction or are we in the business of supporting valuable learning, wherever it may happen? The answer to this question will result in either a narrow or broad interpretation of our role and its relationship to non-instructional forms of learning.

Our own belief is that dynamic learning communities are proper objects of study. We should seek to understand how such communities function, how they grow, how they can be nurtured, and how they can be replicated across diverse settings. But nurturing is different than designing. We must respect the integrity of the community. In time, we may come to think of ourselves more as "learning technologists" than as "instructional technologists", and "learning support specialists" more than "instructional designers." But these are issues best addressed at length in a separate paper.

In conclusion, the development of new communications, storage, and representation technologies constitute a watershed in the history of open learning environments, making DLCs more feasible than they have been in the past. This is a situation where the technology allows a concept to take shape, and the interplay between technology and theory will likely continue in the years to come.

The decision rule concerning DLC versus ID may slide toward DLCs as we learn more about what works. In particular, we need to better understand how established instructional systems (e.g., school classrooms) can migrate toward greater openness, eventually resulting in a displacement of instruction for a community model. A transition model that outline this growth trajectory would be a most welcome research agenda in the coming years.

In the meantime, we will continue studying how dynamic learning communities take shape, how they self-organize, and how they support learning. Documenting cases empirically is an important part of that agenda, and will help to clarify several issues merely touched on in this paper.

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[15] This example comes from our own experience maintaining IT Connections (http://www.cudenver.edu/~mryder/itcon.html). In response to a student's complaint, we could only shrug our shoulders and mumble something about the wonders of an open system!

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Title:

Cultural Assimilation Of The Internet: A Case Study

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ABSTRACT

Despite enormous growth of the Internet and its proliferation of tools, resources, and on-line communities, the connection between local learning environments and virtual learning environments remains tenuous. This paper examines this relationship, based upon a case study of an academic unit at the University of Colorado at Denver. Drawing on interviews, written surveys, and exchanges with students, we offer an analysis of factors that are critical to a user's choice to participate in the Internet. The paper concludes with recommended strategies for introducing students and faculty to networked learning environments.

The Internet has sustained phenomenal growth since the beginning of the decade. Doubling in size each year for the past several years, the Internet now connects 35 million users across the globe. Three million new accounts are added each month. Higher education accounted for most of the growth in the early nineties, but today, commercial usage accounts for 65% of network traffic. The public schools are also wired. The U. S. Department of Education estimates that over 50 percent of American Schools will be attached to the Internet by the end of 1996. Despite this astounding growth, the majority of Americans at this moment remain unwired, anticipating nothing extraordinary about the age of information.

In spite of the Net's growth, most people remain on the sidelines, hearing media reports but staying a cautious distance away from time-consuming forays into the medium. A college campus is a microcosm of the larger community. Some students spend hours in exploration of virtual worlds, some engage in public forums on specific issues, some utilize the Net for its research capabilities, while many adopt the convenience of electronic mail. A substantial body of faculty and students remains largely unaware of the full array of resources available to them.

INTERNET AS A TECHNICAL INNOVATION

One way to look at the growth of the Internet is as a new technology being adopted. Rogers (1995) has developed an influential model for the adoption and diffusion of innovations within organizations; theorists continue to emphasize that today's organizations must be willing and ready to undergo continual change (e.g., Senge, 1990). Seen in this way, a department head or office manager might develop a plan for implementing the technology, similar to the installation of a new computer or LAN. Consistent with this adoption/diffusion approach, Internet resources can be seen as "mere tools" to be utilized by existing organizations and individuals. Through the Internet, an individual may solve a problem, find an answer to a question, or communicate with another professional on a project.

The Internet differs, however, from many technological innovations in that it seems to be largely driven from the bottom—from the academic community and from individuals and small groups of grass-roots enthusiasts. Organizations find themselves responding to an unplanned cultural shift, rather than implementing a new technology from the top down. Moreover, academic units in higher education often lack the cohesion of a traditional business office. Professors are highly autonomous workers who spend more time interacting with students than with colleagues. Developing a consensus for technological change can be a serious challenge in such settings.

INTERNET AS A SECOND CULTURE.

Another way of viewing the Internet is as a second culture or community (Rheingold, 1993). The Internet exhibits all the key elements of a culture, including language, symbols, rituals, status, and other meaning-conveying forms (December, 1993; North, 1995). Individuals may "enter" this environment, become initiated into various sub-groups, and interact with other community members. At the group level, an entire company or department may introduce its members to the Internet culture.

This broader conception underscores the depth of change that the Internet poses to existing organizations. One cannot expect to simply "tack on" the Internet as a cosmetic addition to an existing structure; as a new and competing culture, the Internet is bound to threaten existing conventions and cultural practices.

The gap between the preexisting local community (typically an academic or business unit) and the virtual Internet community is worthy of study. How and why do individuals move toward the Internet culture? How does an entire group of people make the move? What factors are at play, and what can be done to facilitate the change?

This paper draws on our own efforts to bring our local academic culture in line with the Internet culture. Over the last couple of years, we have been using the Internet within our academic unit, the program in Information and Learning

Technologies (ILT) at the University of Colorado at Denver (UCD).[16] We have been intrigued to observe the response of faculty and students as they gravitate toward the Net. An expected normal distribution occurs, ranging from anxiety, frustration, and resistance to utilitarian accommodation to excitement and immersion. In some, these differing responses reflect personal stages of growth over time. We hope the local academic community can overcome initial fears and frustrations and move toward mature utilization of Internet resources much as they might acquire a second language through a semester abroad program. Our hopes, however, have not yet become reality.

Our purpose in this paper is:

1. to reflect on the general problem of the local and Internet cultures;
2. to report on our efforts to support the integration of the two cultures; and
3. to point to areas of needed research and to offer recommendations to designers of learning environments for the successful integration of the Internet into existing learning cultures.

BEGINNING EFFORTS

Martin Ryder wrote a paper in 1994 which articulated his vision of the Internet as a learning tool (Ryder, 1994). To test out his developing ideas, he concurrently developed a homepage to represent the local department's interests and self-concept. Instructional Technology (IT) Connections[17] is an all-purpose hypertext-based help page for beginning and experienced users of UCD computers. Located outside the UCD network's firewall, on a gopher server named Oasis, IT Connections links students with a variety of Internet databases and tools relating to instructional technology and cognitive science. IT Connections has been accessible on the World-Wide Web since the spring of 1994, when it appeared in the Educational Technology section of CERN's virtual library, Stanford's Connections to Cognitive and Psychological Sciences, the Curriculum and Instruction section of EINet Galaxy, and the Education section of John December's list.

The Online Helpdesk is a key component of IT Connections designed to provide documentation, tools and other supports for new users. It includes direct access to gopher resources, usenet and world-wide web utilities, allowing the user to access them in a seamless environment. While the Helpdesk was specifically designed for new users, experienced users maintain active links to the resource for its exhaustive FAQ lists, interest group databases, and practical search tools. For more complete descriptions of IT Connections, the Online Helpdesk, and other performance supports, see Sherry et al. (1995).

HIDING THE COMPLEXITY

Powerful resources have been available to users within our local department from the start, including usenet, gopher, ftp, and telnet. But these tools required the burden of rudimentary Unix skills which effectively kept the resources out of reach of most new users. Not surprisingly, they were minimally used.

Our tactical approach was to eliminate any direct reference to such tools whenever possible. Martin, who works as a software engineer in his daytime job, designed command scripts which enable users to perform complex Unix operations with simple commands. The command, "connect", for example, invokes a script that brings up IT Connections with the Lynx browser, a tool designed at the University of Kansas specifically with new users in mind. For local users, IT Connections serves as their window to Internet services in education. The single command "connect" allows the user direct access to IT Connections without requiring technical knowledge of the underlying details. A similar command, "aid", invokes Lynx to bring up the Online Helpdesk.

Another tool, "makepage", was developed to allow new users to immerse themselves in online authoring without passing through the initiation rites of Unix. The single command "makepage" creates for the user a public directory with an index template. It sets all the appropriate security permissions to allow public browsing of the new directory. The new user is not encumbered with these distracting cognitive tasks. After invoking the command, users can immediately begin editing an html template, customizing it to their own specifications as they begin to mold a personal homepage from a generic model.

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[16] ILT programs are housed within the Division of Technology and Special Services, which is within the Graduate School of Education.

[17] The URL to IT Connections is: gopher://www.cudenver.edu/~mryder/itcon.html

Such conveniences do not come without a price. Users who wish to understand the technical details of Unix and html are not directly rewarded with this approach. But the templates and shells provided by the tools have opened the door for many users whose interests are focused beyond the technology.

THE INTERNET TASK FORCE

In the process of developing these support tools, Martin learned something interesting: He could barely get the attention of anyone around, student or faculty. This was especially ironic, since the department was ostensibly committed to educational technologies as its professional focus. Professors in the program had been teaching telecommunications classes and using e-mail for years. Why didn't anybody share Martin's excitement? Why did faculty members take weeks to even take a look at the Web resource, IT Connections? Martin expressed a sense of disequilibrium and confusion as he contrasted the supportive responses of remote patrons with the general disinterest shown locally.

Undeterred by the resistance shown to the new tools, Martin joined faculty member Brent Wilson and a team of students to study the issue. The Internet Task Force was created in the fall of 1994, with the following broad objectives:

- to support the department in its move toward the Internet culture through a variety of online and offline tools, support, training, and policy initiatives;
- to develop ways that e-mail and the Internet could be used as knowledge-building tools within graduate classes and seminars;
- to reflect on and conduct research on users' needs, support tools, adoption processes, cultural change, and collaborative learning communities.

Our overall goals for student (and faculty) online access involve the ability to engage actively within local and virtual communities toward the social construction of public knowledge. Specifically, we want students and faculty in Information and Learning Technologies to utilize online resources in order to:

- Engage in public dialog over issues of scholarly and professional import.
- Exploit the various resources that comprise a public knowledge base.
- Contribute information of value to the public knowledge base.
- Provide consulting and collaborative services to communities of learners, scholars and practitioners.

The group has met regularly since August 1994, and has created a number of performance supports and research products related to educational uses of the Internet. Sherry et al. (1995) provides a more complete report of the Task Force activities and accomplishments.

USER SURVEY

In spite of our enthusiasm for the potential of Internet resources, we were sensitive to the very real obstacles facing students and faculty alike. In particular, we were wary of mandating policy and enforcing changes in the culture without careful assessment of people's perceptions and needs (Sarason, 1988). We designed a written questionnaire based on Rossett's (1991) needs assessment model, which was intended to survey the level of Internet training and support needed by our students, faculty, and staff. Our primary research questions were:

- What is your current level of use of e-mail and the Internet?
- Do you have access to the appropriate technology?
- What are your objectives in using e-mail and the Internet?
- What obstacles do you face in using them?
- What performance and training supports do you feel would be helpful?

Seven teachers and 66 students (73 in all) responded to the questionnaire. Some of the information guided us in the next phase of our work, i.e.: developing home pages for the School of Education, our doctoral program, and our division, and developing additional job aids and other types of learner support. We have enumerated our key findings below.

We are online. Fifty-nine respondents already had e-mail accounts on one of the university computers. About half learned to use e-mail in classes; the rest learned on their own or from friends.

We are mobile. Those who use e-mail nearly every day connect from home, whereas those who use it weekly connect from home or from the university computer labs. 60 of the 73 respondents have modems and computers.

We have good e-mail access. Most felt their e-mail service was reliable and accessible, and that their system permitted them to download and save files.

We have different reasons for using e-mail. When asked to rate the usefulness of a variety of reasons for using e-mail, the responses tended to cluster into four groups: local access and communication, scholarly research, collaboration, and information dissemination.

- Very useful: use e-mail, locate instructional materials, transfer files from remote locations, consult with classmates, instructors, and advisor;
- Moderately useful: do literature searches, access electronic publications, articles, and scholarly journals, transfer information between home computer and university account, and organize, store, and print information in student account;
- Somewhat useful: observe other Internet sites, participate in electronic discussion groups, collaborate with scholars from other universities worldwide;
- Less useful: author and publish electronic documents with hypertext links to remote sources.

Responses were fairly evenly divided into these four groups, indicating a wide range of utilization of Internet resources.

We have a mix of challenged and experienced users with different needs. Respondents were asked to identify the challenges they encountered using e-mail. From those responses, we separated the early adopters from a group of respondents who seemed to have more difficulties with the technology. The two groups were then compared as they expressed preferences for the eight training and performance support aids which we were considering developing. The rankings, reported in Table 2 below, were very different for each group.

Early Adopters	**Reluctant Users of the Technology**
1. online tutorials,	1. help from graduate assistants,
2. workshops,	2. workshops,
3. paper tutorials,	3. classes,
4. interactive demonstrations,	4. paper tutorials,
5. booklets,	5. interactive demonstrations,
6. classes,	6. brochures,
7. brochures,	7. booklets,
8. help from graduate assistants.	8. online tutorials.

Table 1. Preference rankings for different kinds of performance support, across two user profiles.

It is evident that new users seek face-to-face instruction: either individual attention by graduate assistants in the laboratory, or one- to two-hour workshops and formal classes.

The early adopters included experienced and frequent users. This group seems comfortable with tutorials, both online and paper, whereas one-on-one assistance from graduate assistants was at the bottom of the list—possibly because graduate assistants working in the lab are not formally trained or certified in the use of the Internet!

Interestingly, both groups ranked one- to two-hour workshops very highly (rank=2), whereas formal classes were ranked third from the top by the challenged group, and third from the bottom by the frequent users.

In an effort to uncover users' perceptions, we asked survey respondents a number of Likert-style attitude questions. Responses of ten identified "reluctant users" are reported in Table 2 below.

3.5	I feel intimidated by the techno-gurus in the program.
3.3	I feel I can accomplish the same thing with mail and phone calls.
3.3	I'm the type that needs a lot of hand-holding.
3.1	I'm concerned that I'd have to learn too much technical jargon and commands to make it worthwhile.
3.0	I don't have the time to learn e-mail.
3.0	I would like to see more use of E-mail in my classes.
2.6	I think E-mail is worth the time and trouble.
3.6	Getting access from home is too expensive.
2.4	Learning to use E-mail will pay off for me professionally.
2.3	I think E-mail can help me stay in touch with people better.
4.0	I have a hard time expressing my thoughts in writing.

Table 2. Attitude responses of ten survey respondents who showed a reluctance to use e-mail and Internet resources, with 5 converting to "strongly agree", 3 to "undecided", and 1 to "strongly disagree."

These responses from reluctant users reflect a number of underlying factors—self-concept, social, and practical—that contribute to a person's choice to use e-mail and the Internet in their day-to-day work. In spite of users' reluctance to make use of the technology, their responses indicate a complex relationship with that technology. Discussion of these issues is continued in the section below.

FURTHER INSIGHTS INTO USER PERCEPTIONS

Since the summer of 1993, Brent has been using e-mail as a mode of communication within his classes (Lowry, Koneman, Osman-Jouchoux, & Wilson, 1994; Wilson, Lowry, Koneman, & Osman-Jouchoux, 1994). Students receive e-mail accounts and are encouraged to communicate with each other and with the instructor. Reactions to readings, discussions of the text, class announcements, and questions to the instructors are all commonly communicated electronically.

In the spring of 1995, Brent's doctoral seminar went the next step and began using the Internet seriously as a research tool and as an object of study. The thirteen class members were about evenly divided between students with an interest in technology and other students who took the course as a program requirement. The class spent nearly half the classtime exploring the Internet, developing homepages, conducting searches, downloading files, and participating (electively) in listserv discussion groups.

A group interview with the 13 students was conducted nine weeks into the semester. This group interview served as an important source of information concerning students' motives, attitudes, and perceptions of the Internet as a learning tool. The following questions were sent out on e-mail in anticipation of the interview, and guided our discussion (see Table 3).

QUESTIONS TO NEW USERS OF THE INTERNET

—Did I embrace or resist the technology? Why?

—How did my thinking change as I learned to use the Internet? Were there changes in my mental models? Changes in attitudes? Were there any breakthroughs or "aha" experiences?

—What kinds of supports or experiences were most helpful to me in learning to take full advantage of e-mail and the Internet? Why?

—In what ways can the Internet be used for learning purposes? What is the potential versus the reality? How can the potential be realized?

—Has my experience with the Internet influenced the way I think about technology and education? What do I know now that I did not even think about three weeks ago in terms of how I might use technology for education?

—Can tools like the Internet help us create collaborative, knowledge- building learning communities? Has my experience with the Internet influenced how I think about education and learning in general?

—Are there concerns about potential abuses of technology and education? How can we use the Internet in ways that affirm people's individuality and humanity?

Table 3. Questions put to members of the doctoral seminar.

We have organized student comments around several key factors that affect students' choices to use or avoid e-mail and the Internet. Names have been changed to protect the anonymity of responses. (For a further analysis of features of the Internet which inhibit of encourage interaction, see Ryder, Wilson, & Myers, 1996).

1. *Clear payoff.* There needs to be some compelling need for students to engage in the discomfort attending the learning of new technologies. Says one student: "How is this gonna help me down the road?" Jon used the example of his wife pressuring him to use Quicken for their personal finances. "I have always known exactly what I have in the bank within $5. What do I need Quicken for?"

A goal to use the technology can come from a class assignment or expectation, but also from students themselves. Carl described a personal learning goal he created: To create an electronic portfolio showcasing his work. A portfolio is a major requirement of the doctoral program; Carl decided to do his electronically. With this goal in mind, Carl's heavy participation on the Internet had a focus and purpose.

2. *Overcoming technophobia and technophatigue.* Technophobia is common because it seems there is always some new technology demanding to be learned. Technophobia typically is triggered when two things are coupled:

- a belief in the value or necessity of learning and using a new technology;
- feelings of incompetence or inability to learn the new technology.

Ironically, the higher someone values the technology, the more extreme the phobia can become.

Many people have deeply ingrained feelings of incompetence regarding technology. These feelings of inadequacy, when reinforced by past experiences of failure, can lead to a condition of "learned helplessness" where the person quits trying and becomes entrenched in the avoidance of technology. Persisting avoidance behavior only widens the knowledge gap, leading to a vicious cycle of avoidance, growing incompetence, and feelings of inadequacy.

Several students in our interview reported a need for unpressed time to dabble, observe others, and become comfortable with the technology. Deb said, "It takes me awhile to process, then when I get it—[snaps finger]—I go for it." Kate's strategy is similar: "I soak myself in it for a long time, then I'll use it after I'm comfortable." Kate reported that, because her learning style is conceptual and highly visual, she is developing her own job aids to support her performance. Alta has a friend who lives close by, just across town. But she enjoys communicating back and forth with this friend via e-mail. It's a safe way to practice her new skill. "My daughter and son are both in college. I found out they were communicating over e-mail and it made me curious. If it had been an assignment, though, I would have thought differently about it."

3. *Cultural/personal compatibility.* Technology occasionally conflicts with people's learning styles, self-concepts, and lifestyles. Some people actively resist technology on grounds of principle, believing the technology influences their lives in negative ways. To address this concern, students need skills and tools to manage the complexity and retain a sense of control over the technology (and not vice versa).

Frank, for example, commented on the problem of information overload on the net. He sees the Internet as an open-ended tool, but "the World-Wide Web is a garage sale—There's so much junk out there! I have to be selective in how I spend my time and what resources I use."

Deb described some of the interpersonal dynamics involved in e-mail communications. She found it amazing that the co-worker in the next cubicle would send e-mail to send simple messages rather than just saying "Hey!" across the partition. She also described times when people would post messages laced with an emotional undercurrent, concerning job conditions or personal items. Deb gets a message like this and replies, "We need to talk." At that point, the communication returns to face-to-face.

4. *Proper scaffolding.* People need a "scaffold" or support structure in place as they engage in complex performances outside their normal repertoire of skills. In the case of the Internet, a complete scaffolding system seems to include:

- *Supportive, non-judgmental, social support system.* Scott noted a problem with adult learners. We tend to assume that everyone knows how to do basic things. "I shouldn't have to ask for help—I'm a graduate student!" Then we're embarrassed when don't know what we're doing, and we're afraid to ask. "You don't wanna look stupid, so you're not going to venture out..."
- *Lots of hand-holding.* New users of technology can easily get overwhelmed by the complexity and newness of it all. Greg complained, "We don't know what we don't know." Carl suggested that technology be mastered in small groups of 2-3 learners, maximum. People need personal attention and hand-holding that is not possible in a full class. Five minutes into a full-class demo, some students get lost but won't say anything, because they feel there is nothing that can be done in such a large group.
- *Freedom from technical hurdles.* Richard described his attitude towards obstacles in using technology. "You hit a barrier once—jump over it. You hit it a second time, remove the barrier." Richard described how having a clear

application—a decision to begin implementing e-mail in his own classes—prompted him to make steady progress toward using the technology. "It's like the movie, 'What About Bob'—I'm taking baby steps but I'm getting there."

- *Access*. One student had serious problems initially because he did not own a computer and modem, and had difficulty getting on campus. This lack of access initially affected his attitudes and learning of Internet skills.

Finding a good time to get online is a problem for Alta. "If you look at my times, you'll see that I'm on at 5:00 am. I can't get on during the day—the modem pool is overloaded. Sunday night is impossible." So she logs on before work, which leaves her little time to reflect and respond to mail, even when she is inclined to do so.

Jack had similar access problems. He lives outside the local dialing area, but eventually learned how to telnet from one computer to another. This made communication from home to the university economically feasible.

5. *Finding a voice and having something to say*. Lynn described some of the concerns that are keeping her from finishing her homepage. "The issue of progress isn't with the technology. There's lots of supports—We know how to get help. My problem is the CONTENT, not the technology. I still don't know what I want to put into my homepage, and how I want it to look."

Frank agreed with Lynn. "I used the 'private' command to lock up my homepage until I'm ready to show it off. I'm spending time developing the text document. I want to make sure my stuff is substantive and cogent. I don't want the whole world thinking I'm a fool!"

FOLLOWUP WITH STUDENTS AND FACULTY

To examine possible shifts in students' perceptions and Internet use since the Spring term, a follow-up interview via e-mail was conducted during the fall of 1995. A short questionnaire was sent to the thirteen students who had been enrolled in the spring doctoral seminar.

The students were asked to re-assess their attitudes, perceptions, and use of e-mail and the Internet in relation to their academic work. Seven of the thirteen students replied. Their comments reveal two clusters of students: Some students have remained static or resistant toward technology use, while others dynamically appropriate the technology into their research and communications. Students in the second group have entered into a dynamic relationship with the technology, with their personal and professional growth stimulated by new resources and tools available on the Internet.

This dynamic growth is reflected by an extended use of the Internet as a research tool. Kate experienced a major shift in how she thought about and used the Internet: "What I wasn't tuned into at first was my potential role on the Net...that I could be a resource for others...that I could have a site and offer my wares to the world." Kate uses the Internet almost daily to communicate within the virtual community. She gives credit to a professor who provided support as she underwent this change process.

Another equally enthusiastic adopter is Scott. His use of the Internet has been stimulated by his experiences outside the department. He commented, "...I conferred with an acquaintance in Britain more frequently on e-mail this semester than I did with my classmates at UCD." Scott questions the department's support of the Internet as a resource for students. He is concerned that some students perceive the Internet as not a valued resource or a place to participate in the larger academic community. For technical support, another student, Oprah has also reached out to the broader Internet community, seeking technical help from her daughter, a computer engineer at a university in another state.

In contrast, we noted the work done by the Task Force extends beyond our university walls. One student who sees values in the Internet but uses these resources irregularly, reported that he would use locally developed resources to develop a homepage at a neighboring university.

Janell, an active e-mail user, explains why she doesn't take advantage of Internet resources:

> My thinking has not changed re: the Internet since May. I still think that it is a very time consuming effort to search and/or monitor the Internet for my learning needs. I realize that the vast amount of information available could be invaluable, but I do not currently have the time or the inclination to 'fight' the technology as well as the effort needed to 'find' what I need.

We can only conclude that the six students who chose not to respond to the followup questions may hold similar views. Person-to-person followup may shed further light on these students' use of e-mail and the priority of the Internet in their graduate studies.

Recognizing the central role played by faculty members in setting a tone for a department's local culture, we decided to probe into faculty attitudes. In spite of their affiliation with a technology program—or perhaps because of it!—faculty members can be expected to show varying attitudes toward the adoption of new technologies. Four faculty members in the ILT department were contacted to participate in a telephone interview. Three of the four responded. Two of three interviews were conducted via phone and one via an e-mail interview.

The interviews revealed different levels of use and interest toward the Internet. One faculty member has been using the electronic medium to communicate globally with an entire class, establishing online discussion groups and encouraging individual communication among class members and their professor. Students are encouraged but not required to use online resources for class projects. Another faculty member also encourages students to communicate via e-mail, requiring it for some classes. But non-adopters can be found among faculty members, too. The third faculty member felt the Web is not a credible place to either place a paper or to find published research of fellow academics. Using the Internet is perceived to be a cumbersome, time consuming activity.

Overall, student and faculty comments were consistent with survey responses in showing the diverse responses the Internet can provoke. Some members of the local culture make a conscious, reflected choice to avoid these technologies, while perhaps most make cautious, calculated forays as time and expected payoff allow. For the Task Force, dedicated to continuing the assimilation of the Internet culture into the local culture, these findings provide a clear mandate for respecting diverse points of view and for providing comprehensive support. We are at beginning stages in providing that support, as reported in the section below.

WHERE WE ARE NOW: A PROGRESS REPORT

The response of the Task Force to surveys and interviews have taken a number of forms, including:

—developing information brochures describing local resources;
—creating a student distribution list for job announcements, etc.;
—maintaining and improving departmental homepages and resources;
—a continuing research agenda related to adoption and change.

ILT faculty members, in spite of their diverse views toward the Internet, have responded in turn with a number of supportive gestures, including:

—in many cases, encouraging e-mail use within classes and between advisors and students;
—establishing greater presence of telecommunications, distance learning, and Web authoring in curriculum offerings;
—inserting an e-mail policy statement into the ILT student handbook, mandating regular access.

Overall, the local culture is moving toward the Internet, but we are far from assimilating the two cultures. E-mail us is becoming routinized, but using the Internet varies dramatically, with faculty differences continuing to play a key role. Internet use has not yet transcended individual courses to become a habit among community members in general. A number of concerns remain, including:

—concerns with equity and access from labs, work, and home;
—varying expectations among faculty and courses;
—lack of a graphic interface (SLIP/PPP) from home, resulting in different standards for software and interface;
—continued difficulty getting connected from home;

Increasing forays are being made toward integrating Internet resources into coursework. Most recently, a course is being planned for the spring that will be taught primarily via e-mail and the Web.

A significant factor affecting the adoption of Internet resources within the School of Education is the competition from a School-sponsored e-mail system called Colorado Educators Online or CEO. CEO is based on the First-Class BBS system and allows access to listservs but not the Web. CEO is used as the primary e-mail system by Education faculty members and is promoted heavily to school districts within the Denver metro area. A significant advance has recently been made which allows access to CEO via Netscape on the Web. We are hopeful that once students and faculty invest in SLIP access from home, the Web will be more easily integrated into their regular e-mail activities.

The Internet Task Force continues in its goals to support the integration of Internet resources in the School. We struggle to maintain a dual focus of maintaining Web pages while at the same time promoting and seeking to understand the adoption process. This semester, we have begun splitting these two responsibilities among two sub-groups, one charged with Web maintenance and the other charged with engaging in change research.

CONCLUSIONS AND RECOMMENDATIONS

Theory and practical knowledge about how to use the Internet lags behind the technology itself. This is to be expected. Cuban (1986) surveyed the history of technologies used in education and found a pattern that included initial stages of excitement and hype, followed by predictable backlashes and retrenchment. Initial uses of a new technology tend to mirror existing educational forms and practices—e.g., traditional classrooms, lectures, and control structures. Eventually we expect to see greater departure from traditional educational forms, with the Internet enabling new paradigms and approaches to learning (Blurton, 1994; Lemke, 1993).

To understand people's use and resistance of the Internet, we have felt a need to go beyond traditional adoption models (e.g., Rogers, 1995). The coming role of e-mail and the World-Wide Web in people's lives may better be understood when seen in systemic, organismic, and chaotic terms (Bateson, 1972; Kelly, 1994). We are presently drawing on theoretical frameworks of biologists, cognitive psychologists, and anthropologists as we seek to understand the learning potential of the Internet.

Our observations have also heightened our awareness of the difficulty in bringing two cultures together. Users must surpass a number of barriers as they become initiates into the Internet culture. We found the technical barriers to be the easiest ones to solve. But there are many more that are rooted in culture, lifestyles, learning styles, paradigms, and comfort zones. These cultural aspects of Internet use provide rich opportunities for further research, theory development, and guidance for practice.

David Perkins (1996) notes an important kind of learning that is not often acknowledged in formal school settings: *Knowing your way around*. Just as we knew our way around our neighborhood as children, Perkins suggests that knowing our way combines a number of kinds of knowing, including:

> ...having a sense of orientation, recognizing problems and opportunities, perceiving how things work together, possessing a feel for the texture and structure of the domain. It encompasses not just explicit but tacit knowledge, not just focal awareness but peripheral awareness, not just a sense of what's there but what's interesting and valuable....*[K]nowing your way around resonates with the notion of a learning environment.* (p. *vi*)

Knowing our way around can be critical in a variety of domains:

> We can speak sensibly of knowing your way around the stock market, playing baseball, and any discipline, for instance physics or English literature. To really know any of these domains requires a kind of flexible orientation to what things and places they contain, what resources they afford, and how to get jobs done.... (Perkins, 1996, p. *vi*)

We agree with Perkins. People who learn their way around the Internet are learning more than facts, rules, and procedures. As Perkins notes, being able to "get around" an information-rich environment is closely related to mastering the complexity of modern disciplines (*cf.* Kelly, 1994). Through the Internet and similar collaborative learning environments, people can become enculterated into new disciplines and knowledge-building communities (Scardamalia & Bereiter, 1994). Students facing limited resources in their local environments (e.g., an under-funded, inner-city school) potentially can reach out to unlimited resources on the Internet. The possibilities are staggering: The Internet has the potential to be an "equalizer" that introduces novice outsiders into a rich community full of resources and expertise.

Of course, something is missing from the picture. Impoverished or dysfunctional local communities will not prepare students with the metacognitive and dispositional qualities needed to take advantage to a rich virtual environment. Students who have never "seen the light" of day cannot be expected to rush outside and begin playing football on the lawn. Even so, the Internet may come to serve as a "Trojan horse" in such limited local environments, subverting the established order, providing a second voice or second perspective that will stimulate change at the local level.

Even within healthy local environments, providing clear guidance for practitioners is a challenge as they try to incorporate the Internet. Understanding the factors affecting use, however, should help educators get a better grasp of methods to bridge the gap between the two cultures. In this light, we offer the following recommendations to educators using the Internet:

1. Provide experiences which guarantee first-time success (e.g., don't require users to install and configure their own software).
2. Provide ample scaffolding from initial direct hand-holding to on-line job aids and help facilities, to on-going human (peer) support. Everyone in our study benefited most significantly from direct, live, person-to-person support.
3. Integrate Internet resources by providing authentic tasks that provide students legitimate reasons to use the technology.
4. Integrate Internet resources into traditional classrooms, but also cultivate informal, student-directed uses. Internet adoption will be most successful in organizations that encourage independent and collaborative inquiry, student-directed learning, and professional responsibility.

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5. Encourage adoption of Internet cultural practices through a variety of incentives, policies, and practices, but keep to a minimum explicit mandates and requirements. Seek to create an atmosphere of expected and natural Internet participation without the feeling of coercion.
6. Encourage students to represent themselves to a world-wide community of learners by offering unique contributions to society's knowledge base. This single strategy affords ownership and empowerment—the learner has made her presence known in cyberspace. She is attached to the World-Wide Web!

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Title:

Meaning Negotiation, Knowledge Construction, And Mentoring In A Distance Learning Course

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INTRODUCTION

Technology tools have been used in schools, corporations, and government agencies to extend or enhance both physical and/or cognitive human capabilities in work and study. In education, they have been used to facilitate and revolutionize teaching and learning. Distance learning is one of many educational initiatives that has greatly benefited from the advent of recent technology tools, such as electronic conferencing systems, resource sharing systems, and group access support systems. The relatively low-cost electronic conferencing system is proving to be a powerful and increasingly popular medium--either for totally 'online' courses or for more conventional in-classroom and distance learning courses (Verdejo & Cerri, 1994). Electronic conferencing promotes student-centered learning. That is, it no longer emphasizes the teacher as gospel or the primary source of knowledge. Different kinds of electronic conference software packages provide technical and pedagogical support for organizing and structuring conference topics and message retrieval.

The present study describes how VaxNotes, an electronic conference software, was used at a large midwest University in a graduate distance learning course "Interactive Technologies for Learning". In that course, students' electronic discussions and knowledge construction as well as instructors' methods for organizing the electronic conference in distance learning course were saved and analyzed. The study revealed and discussed patterns of students' electronic discussion and knowledge construction practices. Additionally, this study reviewed and analyzed various ways of organizing the electronic conference and mentoring in this distance learning course. In effect, this study provided insights into how to employ electronic conferencing technology in facilitating teaching and learning by informing teachers of what technology was used in the classroom and how it was used as well.

It is hoped that the study will be informative and will perhaps inspire other instructors to employ social and cognitive learning theories in an electronic conference. The work presented here can be a springboard for other researchers to use social and cognitive learning theories as the theoretical framework for continued research in computer conferencing.

THEORETICAL FRAMEWORK

Vygotsky's learning theory and theories of cognitive and constructive learning provide a helpful theoretical framework for the present study.

The conceptual framework of Vygotsky's theory provides a good basis for understanding learning as a process of social negotiation and collaborative sense making, and mentoring as an effective technique to assist students in collaborative activities and knowledge construction. One of the key concepts in Vygotsky's theory is the zone of proximal development. Vygotsky defined this as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers"(1978, p 86). This definition expresses Vygotsky's notion that what children can do with the assistance of others might be, in some sense, even more indicative of their mental development than what they can do alone (Meichenbaum, et al. 1985). Their achievements in a supportive social environment make the largest contribution to their cognitive development (Fowler & Wheeler, 1995).

A related important concept in Vygotsky's theory is his idea that intellectual development takes place between people before internalization takes place. Vygotsky contended: "Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane and then it appears on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category"(1981). That is, our social and cognitive development occurs when we are interacting with peers and experts. The interactions with peers and experts in the social content and context transform the interpersonal process into the intrapersonal process. Socially displayed values, theories, and ideas are thus internalized in individuals through this transformation.

From this point of view, instruction is most effective when it is in a form of discussions or dialogues wherein learners can interact with peers and adults or mentors who challenge, support, and scaffold their learning. As sociological researchers point out, instruction should take place in a social environment, in which learners use socially mediated and intellectual tools to achieve cognitive development (Rogoff, 1990). Here, the instructor designs learning activities in the zone of proximal development. This zone is neither a property of the child nor of the interpsychological functioning alone, but is jointly determined by the child's level of development and the form of instruction involved. The challenge to educators is to develop forms of instruction so that interpsychological functioning can be structured to maximize the growth of intrapyschological functioning (Wertsch, 1990).

An electronic conference in distance learning courses or regular courses can be viewed as a device through which interactions between learners and instructors can take place. By using the electronic conference, they both can voice their opinions and reflect on their learning. As indicated, these interactions among learners and instructors increase interpsychological and intrapsychological activities and maximize individual's cognitive growth and development.

The social aspect of learning and intellectual development is one part of the theories guiding the present study. The other part is the view of learning as a constructive process of engaging in self-regulated, constructive, and reflective activities. Quite a few theorists challenged the traditional role of the teacher and the student. They argued that the role of teaching and other instructional media is shifting from one that seeks to maximize the communication of fixed content and skills to one in which students are led to experience the knowledge construction process (Knuth and Cunningham, 1993). From this perspective, students construct interpretations, appreciate multiple perspectives, develop and defend their own positions while recognizing others, and become aware of and able to manipulate the knowledge construction process itself. That is, students are no longer passive recipients of bodies of knowledge, but are actively involved in the knowledge-building process, in which they discuss, elaborate upon concepts, and devise relationships among them, and in which they view multiple perspectives on concepts or issues, and generate their understanding based on prior knowledge and current understanding.

"While the individual learner is the only one who can construct his or her unique understanding of the world, this understanding emerges in a social context" (Cunningham, Duffy & Knuth, p. 25. 1993). We view the electronic conference in the distance learning course as the social context from which individual understanding is emerged. The electronic conference provides a space for students to exchange ideas, discuss issues, and join efforts in searching for solutions to problems. It enables asynchronous collaboration in the distance learning course.

Learning is not only active, constructive and cumulative but also a goal directed process. It is goal oriented in that learning is most likely to be successful if the learner is aware of the goal towards which he or she is working and if the learner holds expectations that are appropriate for attaining the desired outcome (Schuell, 1988). Learning requires learners to engage in collaborative activities and in self-regulated and reflective activities as well. The distance learning course in this study provided such opportunities and experiences for learners. While students were participating in the electronic discussion, they engaged not only in interaction and collaboration with peers, but in such activities as goal-setting, planning, and monitoring as well.

John Dewey once argued that human intelligence and all learning are cultivated through reflective thinking (1933). When individuals examine and test their ideas with a purpose, they are better able to use their knowledge in informed and self-directed ways. The electronic discussion not only enables interaction and collaboration but promotes self-regulated learning activities and reflective activities as well. Reading and responding to peers' and instructors' notes forces students to think, form ideas, and articulate them in a meaningful and sensible way. Reading the peer's and the instructor's thoughts urges students to compare them with their own thoughts and ideas, and to examine their own understanding and interpretations.

The reflective activity in the distance learning course thus involves students' self-appraisals, reflection on the class and on past experience, and re-construction of concepts and ideas. In the reflection process, existing knowledge is re-constructed to yield new perspectives. The essential components of any effective learning are social interactions, reflective activities, constructive activities, and self-regulating learning activities. It is under these theoretical and epistemological beliefs that the current study was conducted. Furthermore, these beliefs are consistent with those reflected in the readings and articles chosen for this graduate distance course.

METHODOLOGY

Setting and subjects

The study was conducted in a 16-week graduate seminar--"Interactive Technologies for Learning"--co-taught by two instructors at a large midwestern University Spring, 1995. The seminar focused on the discussion of "the notion of the computer as an educational tool." It incorporated an assortment of lectures, demonstrations, videos, and small and large group discussion activities as well as few live class discussions with authors of selected readings through CU-SeeMe.

The students in the course were mostly in Masters and Ph. D. programs such as Instructional Systems Technology, Educational Psychology, and Telecommunications. They met for three hours every Monday during the spring semester. Students at two campus were connected via video and audio distance learning technologies, so that they could see each other and their instructors at both ends. Each class period was usually devoted to a variety of activities such as the instructors' summarizing weekly readings, class discussions of readings, and students or instructors demonstrating computer-mediated tools for learning. An average of 80 pages was assigned for each week's reading.

Consequently, though each student could voice his/her opinions, understandings and questions about weekly readings during a session of three hours, a thorough discussion of readings and multiple perspectives of readings could not be achieved during the allocated class time. Thus, most of the discussion about weekly readings and sharing of individual understanding took place in the form of computer-mediated communication(CMC). In this case, it was E-mail and VaxNotes. E-mail was the primary communication channel for the first two and half week's discussions. Later class discussions gradually migrated into VaxNotes.

The student electronic discussion consisted of four major components: instructor's introductory questions and reading advice, weekly starter comments, weekly wrapper comments, and participant comments. The instructors designed the starter, the wrapper, and weekly participant roles for the students. Their participation in the electronic discussion was worth 25 percent of the final grade. Students assumed a starter or wrapper role just once during the semester, but were asked to participate in some manner each week.

As a *starter*, a student might: (1) state reactions and questions and make suggestions for the upcoming readings; (2) point out the relationship of an upcoming topic or articles to past lectures or readings; (3) discuss the position of a pioneer in the field; (4) discuss a recent visit to a technology center, exhibit, or conference demonstrating computer tools; (5) attempt to relate student prior learning and discussion to the current week's readings. In effect, the starter role was intended to provide the class with key themes, issues, or questions leading to the upcoming week's readings.

The *wrapper* role, on the other hand, was meant to bring some of the discussed issues and questions to some sense of closure. Summarizing and synthesizing key points and themes was within the wrapper's purview. Therefore, as a wrapper, a student might: (1) react and reflect on any lecture, discussion, or demonstration; (2) restate and reflect on the starter's initial points for that week; (3) point out questions and concerns that have yet to be answered; (4) note any additional related readings; or (5) react to a guest speaker's ideas or a unique class activity.

As a *weekly participant*, one might: (1) participate in the discussion; (2) answer questions and concerns of other participants; (3) question or respond to a peer at another site; or (4) bring to everyone's attention a related conference, issue, newspaper article, or grant proposal.

Data

The data was collected from both E-mail and VaxNotes discussions. A total number of 408 notes were collected from E-mail and VaxNotes. Of these, 84 notes were contributed by the instructors. Quantitative analysis was performed on all the data collected; however, due to the vast amount of data, a qualitative, descriptive, and detailed analysis was conducted on the discussion of only two randomly selected weeks (Week 9 and Week 12).

The collected E-mails and VaxNotes messages were coded into participation categories such as question, reflection, discussion, comment, and answer. Additionally, each student and instructor during the discussion was studied in roles such as contributor, wanderer, seeker, and mentor. Patterns of the student electronic discussion, interaction, and knowledge construction were discussed based on the analysis of participation and role categories. To further complete this teaching and learning picture, the instructors' contributions were analyzed in the way of planning, introductory questions, contributing toward discussions, commenting on students' responses, and guiding students' learning.

Framework for analyzing data

The data analyses disclosed the relationship and the nature of students' and instructors' notes in the electronic conference, thereby providing a better understanding of how students construct new knowledge and understanding, and how electronic conferences can be efficiently organized to facilitate learning. The analyses required not only an understanding of how students contributed to the electronic conference but also a familiarity with the content area to help determine the role of each student, and the evolution and development of an idea or a topic. No previous analytical framework or coding schemes, such as conversation analysis (Schegloff, 1981) or protocol analysis (Ericsson & Simon, 1984), could be readily applied to suit such unique analyses of data.

For the purpose of this study, a specific coding scheme was constructed. The scheme incorporated both Hatano and Inagaki's (1991) theory of group interaction and Graesser and Person's (1994) theory of question analysis. Construction of knowledge through social interaction can be observed in two types of interaction, *horizontal* and *vertical* (Hatano & Inagaki, 1991). According to Hatano and Inagaki, both vertical and horizontal interactions could refer to the interactions among peers. In the *vertical interaction*, some group members will concentrate on looking for the more capable member's desired answers rather than contribute to and construct knowledge. By contrast, in the *horizontal interaction*, members' desires to express their ideas tend to be strong, because no authoritative correct answers are expected to come immediately. Therefore, the members often express a variety of ideas and participate in the exchange of ideas which are likely to be examined and elaborated in such interaction (Hatano & Inagaki, 1991).

The coding scheme for data analyses consists of participant categories, types of interaction, and note categories (See Table 1 & Table 2). In the participant category, four kinds of student roles were identified, such as contributor, wanderer, seeker, and mentor. Two types of interactions were distinguished. Notes were classified according to meanings as reflective notes, comments, discussions, answers, information sharing notes, scaffolding notes, and questions.

Two main types of questions are detected in the electronic conference. The first, Type I, is information-seeking questions (Graesser & Person, 1994). When a genuine information-seeking question is asked, the questioner is missing information and believes the answerer can supply it (Graesser & Person, p. 108). Van der Meiji (1987) identified several assumptions underlying a genuine information-seeking question: a) the questioner does not know the information asked for in the question; b) the questioner believes that an answer exists; c) the questioner wants to know the answer; and d) the questioner believes that the answer will not be given in absence of the question (Graesser & Person, 1994).

The other, Type II, is discussing questions. Assumptions underlying discussing questions are: a) the questioner can provide some kind of explanation to the question, but he believes that it may not be complete nor most appropriate; b) the questioner understands that there are no existing and ready answers to the question; c) the questioner would like to seek opinions from peers or experts; and d) the questioner intends to start a dialogue among peers rather than ask for answers. Questions here are usually deep-level ones regarding particular research issues but normally without definite answers.

Reflective notes are defined as any reflective thoughts running through participant notes. These can be: a) evaluation of the class and learning; b) self-appraisal of learning and understanding; c) instances of comparing and relating past readings or past experiences to current readings and understanding; and d) instances of self-adjusting learning goals and objectives. The main characteristics of reflection here are evaluation, (self)appraisal, and (self)adjustment.

Comments refer to any non-interrogative statements concerning readings. Examples of comments could be: "I agree (disagree) with...", "The author is right in ... ", "The question raised in the article is very important ...". The main characteristic of comments is students' voicing judgments or opinions.

Answers refer to statements which provide specific information to the Type I question--information-seeking question. These, for instance, may be key quotes, basic facts, procedural knowledge, and stories from one's readings.

Discussion and information-sharing notes refer to general statements relevant to discussion topics. These may include: a) elaboration on discussion topics; b) exchanges of thoughts or ideas on related concepts and issues; c) personal understanding; and d) topic-related discussing questions.

Scaffolding notes refer to those providing guidance or suggestion for discussions or readings. They can be notes from either the instructor or the students.

Table 1. Note Category and Interaction Type

	Note Category	Characteristics and Examples	Interaction - Type
1	Type I Question	Ask for information or requesting an answer "What does hypermedia mean?"	Vertical
2	Type II Question	Inquire, start a dialogue "How can we resolve the control issues such as governing the shared space when using a collaborative tool?"	H
3	Answer	Provide answers to information-seeking questions "Hypermedia means ... "	O
4	Information sharing	Share information "My colleague and I have done a lot of thinking about the nature and effect of simulations .... "	R
5	Discussion	Elaborate, exchange, and express ideas or thoughts "What intrigues me from this week's readings is not how we define a tool, ... but rather how tools change ourselves..."	I Z
6	Comment	Judgmental "I agree with A that Schorr's article was ..."	O N
7	Reflection	Evaluation, self-appraisal of learning "I found the class last night to be completely frustrating yet intellectually stimulating . ... it is what makes me think!"	T A
8	Scaffolding	Provide guidance and suggestions to others "... let us not move our lives in this same 'scripted' direction. Use the tool as an idea generator, a place holder of ideas ... "	L

As indicated, while in vertical interaction, the individual concentrates on looking for desired answers rather than expressing or exchanging opinions. Whereas in the horizontal interaction, students express and exchange views, directly contributing to the discussion and knowledge construction.

Constructive learning is viewed as being active, cumulative, goal-oriented, and constructive (Schuell, 1988). However, this does not mean that all constructive learning proceeds or should proceed according to all of these lines at the same time (Simons, 1993). In reality, it may be that active learning periods and passive ones follow each other, especially for learning over a long period of time. In essence, learners' behaviors change in the process of learning. They could be very active, highly motivated, and reflective at one time but less active, motivated, and reflective at another. To apply this perspective to analyses of the present study, the discussion participant was identified as contributor, wanderer, seeker, and mentor according to the nature and the content of the notes (See Table 2).

Table 2. Participant Category

Participant Category	Involved Categories
Contributor	Categories 1 - 8
Wanderer	Mainly categories 1, 4, and 6
Seeker	Category 1
Mentor	Categories 1 - 8

Each participant in the discussion was viewed as contributor no matter what type of note was contributed. Information-seeking questions, for instance, brought others' attention to questions which might otherwise have been ignored. The following quote was representative of a large number of other participant notes in the electronic discussion.

> "The articles this week really made me think about the way people learn, especially the Envisioning Machine article. It is amazing that kids are able to go from not knowing anything about physics and eventually are able to make sense of it without a teacher in front of them telling them what to do. I think the key is that all of us want to make sense out of the world. We are weird from birth with the ability to take previous experiences and build upon them to discover new concepts. The important part here is that the learners did not do it on their own, but in order to make sense of the situation, they had to rely on each other and negotiate an understanding."

The student here expressed an opinion of learning and discussed how children rely on each other and collaboratively make sense of the world around them. By posting this note, the student brought to the class discussion a unique perspective on this learning issue.

Wanderers are the ones who seem to be lost, for at least the time being, in the reading or the discussion. Those notes usually discussed teaching and learning in general rather than specific issues in weekly readings. They reflected a specific learning stage where learners are floundering, re-adjusting themselves, and striving for an understanding of the issue by relating and associating different pieces of information and knowledge. This stage is an important precedent to learning and understanding. The wanderer's notes contribute to the discussion from a different angle; that is, not through elaboration, but through creating perturbation and conflicts in the reader.

Seekers are the ones who feel an information deficit and a need to seek information in order to gain a better or an appropriate understanding of the issue. A seeker, for example, wrote: " I don't understand what they meant by shared space. I read the section more than once, but the idea doesn't want to sink in my mind. Can you help?". The "seeker" here apparently does not have enough knowledge and understanding about the concept--shared space. Without this, the "seeker" could not comprehend the meaning after reading the article.

Mentors are those who when reading participant notes, try to understand the participants' interpretation and knowledge levels and guide them in their reading or help them defend and develop their own ideas and understanding of issues. A mentor in the discussion of Week 12, for instance, said: " Note A commented that the IdeaFisher could constrain one's creative thinking because you are using someone else's opinion of what things might be associated with other things. In fact, every piece of software you use could be considered an interpretive work at some level ... ".

While students and instructors could fall into any of these categories in the electronic conference, the period of time one is in the categories of seeker and wanderer is usually transitional and temporary.

The analysis of this study consisted of close reading of every note and counting note length and the number of notes and contributors. Each note was read and analyzed at the sentence and the paragraph level with a concentration on its meaning. Thus, main ideas of the sentence or the paragraph were listed as points for the discussion. The pattern of the electronic discussion and knowledge construction was generated using these main points and analyzed according to the framework previously discussed. The techniques of writing, grammar, rhetoric, and the like were deemed less pertinent and important to the study and thus were ignored during the analysis. Likewise for the start-up, transitional, and wrap-up words and phrases.

ANALYSES

While a general analysis examined the semester-long discussion, a detailed analysis was conducted on two randomly selected weeks to examine the pattern of electronic discussions and knowledge construction, the role of the instructor and the student, and ways of mentoring used in the electronic conference. The weeks selected and their topics were Week 9--"Science tools for collaboration in a learning community" and Week 12--"Music, art, visualization & animation tools for creativity & critical thinking".

Table 3. General Analysis for a 15 Week Discussion

Week	Topic	Number of notes	Number of contrib-utors	Average line length	Instructors' notes & percentage
1	Introduction: Trends in computers as cognitive and sociomedia tools	10	7	7.68	5 (50%)
2	Linking tools to learner centered psychological principles	17	13	20.5	3 (17%)
3	Learner centered design	16	14	40.9	6 (37%)
4	Multimedia composition and knowledge construction	35	18	41.06	6 (17%)
5	Writing tools for idea generation and cognitive enhancement	24	16	54.6	5 (24%)
6	Distance writing collaboration tools & computer-mediated communication	24	16	32.14	7 (29%)
7	Internet, Mosaic, WWW, & other information systems	29	16	30.2	6 (20%)
8	Science tools for collaboration in learning community	40	18	30.8	4 (10%)
9	Science tools for conducting inquiry	32	15	29.8	3 (9%)
10	Math tools for problem solving and problem representation	31	15	35.35	10 (31%)
11	Computer programming & CAD systems for designing knowledge	32	19	39.78	7 (21%)
12	Music, art, visualization & animation tools for creativity & critical thinking	23	17	36.4	2 (9%)
13	Virtual reality, intelligent tools, & other dreams of reality	32	19	37.09	6 (18%)
14	Student self selection Week	21	18	28.5	2 (9%)
15	Cognitive and sociomedia tools revisited	14	12	44	1 (7%)
*	Other creative reflections	8	8	18.75	0
**	Tool taxonomy presentation (one of the assignments)	20	12	16.35	8 (40%)
Total /Aver-age		408 / 27	14	32 lines	

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[*] "Other creative reflections" is not a weekly discussion topic, but notes contributed by students throughout the semester about their reflective thoughts.

[**] Tool taxonomy presentation is one of the class assignments. Students put their discussion notes about the assignment under this topic exclusively.

General analysis

Quality. Fifteen weeks' electronic discussions generated a total number of 408 notes (See Table 3) from 17 discussion topics. The average number of notes contributed each week was 27. The note length ranged from 8 lines in the first week to 55 lines in the fifth week. The average note length across the 17 topics was approximately 32 lines. Each line was roughly 10 words, making an average note length of approximately 320 words. Of all the discussions in 15 weeks, only the first week had an average length of eight lines. The rest all exceeded an average of 20 lines. Three hundred and twenty words could fill one page and 550 words could be printed on almost two pages double spaced. The quality of the electronic conference is closely, though relatively, related to its quantity or note length. Clearly, students here were not simply raising information-seeking questions, but were really writing thoughtful reflections, discussions, and comments.

Students' involvement. The number of contributors was steady across all the discussion topics and in appropriate proportion with the number of notes in each week given the number of students taking the class. The smallest number of contributors was 7 and the largest was 19 in the class of twenty-two students. Over 73% of the students participated in the electronic discussion each week, with a participation rate ranging from 35% in the first week and 95% in the eleventh week. If we excluded the first week, when students were starting to use the electronic distribution list for this class, the participation rate would be even higher. Clearly, the discussion space was not dominated by a few students, nor was it swamped with socializing statements, greetings, or information-seeking questions which might be used to earn a participation grade for this class. As indicated above, students mostly posted thought-provoking questions, discussions, and reflections.

Instructors' involvement. Of the total number of notes, 86 notes were contributed by the instructors and accounted for an average of 20%. The percentage ranged from 7% in Week 15 to 50% in Week 1. Scaffolding was high at the beginning of the semester. For instance, in the first week, the instructors' notes accounted for half of the class notes. Most of these notes were to suggest discussion parameters, call for students' participation, and ensure that the E-mail distribution list worked and students responded to it. As the semester moved on, instructors' notes gradually reduced to around 20% with the exception of Week 3 and Week 6 in which the instructors' notes reached over 30%. The discussion topic of Week 3--learner-centered design--drew interest from both students and instructors. The discussion topic in Week 6--writing tools for idea generation and cognitive enhancement--was one of the instructors' special interest area, where he had vast research experiences. In that week's discussion, he shared his expertise and guided students in understanding the use of computer tools to help generate ideas and enhance cognitive development.

Specific analysis

Starter Notes. Detailed data analyses focused on starter, wrapper, instructor, and student participant notes, on specific discussion topics, and any other notes posted in Week 9 and Week 12*. For our analyses, main ideas of each note were summarized, synthesized, and listed in tables. Each note reflected each individual's unique understanding and represented individual's unique contribution to the discussion. The starter's note, to some extent, led a week's discussion. For example, the starter of Week 9 wrote:

> " I think one of the issues we need to address is relevancy. I found it a lot easier to appreciate the role of Sherlock I (Lajoie's article) and the Medical Center program (Anderson's article) as an instructional aid, than I did when I read about Bio-World (Lajoie's article) or the Envisioning Machine (Teasley's article). Both Sherlock I and Medical World have a high degree of relevance to their users, who desire to benefit from using these

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* Assigned articles for Week 9 are: 1) Constructing a joint problem space: the computer as a tool for sharing knowledge; 2) Computer environment as cognitive tools for enhancing learning; 3) Medical center: a module hypermedia approach to problem design; 4)Video labs: tools for scientific investigation; and 5) Wireless coyote: a computer-supported field trip.

Assigned articles for Week 12 are: 1) Socratic approach to use computers with at-risk students; 2) Visual languages for cooperation: a performing medium approach to systems for cooperative work; 3) Prototyping multimedia: lessons from the visual computing group at Project Athena Center for Educational Computing Initiative; and 4) Programs that help you think creatively and plan effectively.

programs. Granted the Medical Center program and the Envisioning Machine can promote problem solving, but is problem solving useful or always possible in the absence of relevancy to the user?"

The starter here raised and discussed the issue of relevancy in using tools. The issue was then picked up, discussed, and commented on by six other individuals during Week 9 (See Table 4).

Table 4. Discussion on the Issue of Relevancy in Using Tools during Week 9

Participant Category	Note	Main Ideas	Note Category
C	N. 1[**]	Discuss the issue of relevancy in using tools	Discussion
C	N. 5	Discuss relevancy issue raised in Note 1	Discussion
C	N. 6	Discuss relevancy issue (Note 1)	Discussion
C	N. 7	Comment on relevancy in applying tools	Comment
C	N. 13	Discuss the relevancy issue (citing three comments from the previous notes) and suggest that relevancy is related to knowledge transfer, far and near.	Discussion
C	N. 15	Reflect on the issue of relevancy	Reflection

(C= contributor; W= wanderer; S= seeker; and M= mentor)

In both Week 9 and Week 12, students tended to carefully read the starter's note and answer the questions or discuss issues raised. The starter of Week 12 discussed visuals used in daily life and education, and raised a number of discussing questions about weekly readings. He wrote: "The art or visual has been disregarded in education for a long time. Now, we recognize that the information age is multidimensional and the computer is a way for us to grasp the enormous amount of usable information. We see computers as new ways of seeing. Some questions rise from here: How do we conceptualize with vision? How does the use of computational visual affect learner's cognitive development?". Once again, the starter's note initiated a heated discussion on visualization and learning in Week 12 (See Table 5).

Table 5. Discussion on Visualization and Learning during Week 12

Participant Category	Note	Main Ideas	Note Category
C	N. 1	Discuss the number of visuals used in daily life and old saying --picture is worthy a thousand words Discuss that visuals have been neglected in education Raise inquiring questions (1-5)	Discussion Type II Qs
C/M	N. 5	Comment on the blackboards in the halls of the Chemistry building and lack of it in Education building Share experience with the class on visualization	Comment Information Sharing
C	N. 6	Discuss Latin's article (creativity -- people use each other's ideas to develop a better end product) and raise questions concerning working with group Reflect on personal experience working in groups	Discussion Reflection
C/M	N. 7	Discuss Vmacs	Discussion

[**] The note number signifies the order in which the note was contributed. The number uniquely identified each note but does not carry any other meaning.

Table 5. (continued)

Participant Category	Note	Main Ideas	Note Category
C	N. 10	Discuss visualization	Discussion
C	N. 18	Summarize different comments on visualization	Discussion
C/M	N. 19	Response to one previous question--visualization seems to be rising in importance	Answer Scaffolding
C/M	N. 22	Share experience on how teachers and students collaborate in teaching and learning Discuss visualization	Discussion Type II Qs

Table 5 lists notes from eight students during Week 12. These notes, though falling into different categories such as comment, discussion, information-sharing, and scaffolding, all centered around the discussion of how visualization being used in daily life as well as in instruction. Quite a few referred to the blackboards in the chemistry building on campus and commented that the blackboard served as a space for visualization and for exchanging ideas as well. One mentor here related visualization to tools and learning, and reiterated the importance of visualization in learning. Mentors acquainted peers with some real world practices for using visualization in teaching and learning.

Wrapper Notes. The wrap-up for the weekly discussion did not demonstrate its expected value to synthesize the groups' understanding of the readings. In most weeks, the wrapper simply expressed his/her personal feelings and summarized the individual understanding of topics discussed. For example, the wrapper for Week 9 wrote: "I particularly enjoyed the readings for this week. I am sure that part of the reason is that they were concerned with subject matter that I am familiar with, so my ability to envision the tools discussed was enhanced. .. I agree with student B that the thrust of Lajoie's article are the 4 tools that assist learners to accomplish cognitive tasks." In some other weeks, the wrapper technically summarized what each student and instructor contributed without pulling them together or synthesizing these ideas. For example, the wrapper for Week 12 wrote:"... Student C raised a question of 'the chalk board in the Chemistry Building' which a couple of people replied that they will agree with this idea--gathering information from more than one source...". Wrappers read discussion notes, reflected on them, but often offered few insights or summaries.

Instructor Notes. During Week 9, the instructors contributed three notes which accounted for 9% of the total. Three notes involved general comments to the class and suggestions for future learning. The instructor reflected on the history of computing and tools evolution, commented on tools and theories guiding the development of tools, and encouraged students to take part in the role play (See Table 8). He discussed different types of tools related to five levels of learning as well as four different types of cognitive tools identified in the readings. Additionally, he pointed to his own experiences to guide students in understanding the concept of cognitive tools. For instance, he wrote: "She (Lajoie) says that there are 4 types of cognitive tools that can be identified by the functions that they serve... they support my memory and strategic thinking, give me the facts so I don't have to waste my time, enable me to engage in new activities, and get me to test and explore new things...". Such restatement and simplification of the readings were typically offered by the instructor after the weekly starter's comment and students' wandering or queries. According to the instructor, this was useful and necessary.

Table 6. The Instructor's Notes during Week 9

Participant Category	Note	Main Ideas	Note Category
C/M	N. 9	Reflect on the history of computing, Reflect on tools evolution, Encourage debate and role play	Reflection Suggestion
C/M	N. 14	Comment on surfing the net and the related jobs, Comment on tools vs. theories	Comment Scaffolding
C/M	N. 24	Comment on learning in the class, Share information about other available materials related to the class, Suggest students' writing proposals for conferences, Comment on the previous class (agree with Note 22), Discuss different kinds of tools and levels of learning, Discuss four types of cognitive tools identified in one reading	Scaffolding Comment Suggestion Discussion Information Sharing

During Week 12, the instructor contributed two notes, comprising 9% of the total. The instructor commented on the metaphor used by one student to describe thinking and clarified that we are emphasizing process skills in education today. He challenged students with such questions as whether computers really can teach such process skills. Next, the instructor responded to a participant note about how computer software can assist cognitive development. He further illustrated how a tool, e.g. Writing Partner, can help people think and plan creatively. Using his own experience and understanding, the instructor guided students' learning by reading their notes and explaining how tools can be used to help people think and plan. In reflection, the instructor later said that he was always focusing on assisting students in their understanding of the issue.

Topic Discussions for Week 9. The topic of collaboration brought together five students to exchange ideas and opinions. They engaged in a lively debate about differences between cooperation and collaboration and examined the relationship between the information explosion and collaboration. One student wrote: "They (authors) make a distinction between collaborative and cooperative problem solving that I hadn't given much prior thought to. Cooperative meant that there was a division of labor in the problem-solving but collaborative meant that everyone was engaged in trying to find a solution." Another student related the information explosion to collaborative learners and workers: "Because of knowledge explosion, ... they (students) must learn to be collaborators, because being able to access the information doesn't mean knowing how to apply it or if it is the right information to apply."

The discussion in Week 9 well illustrated Dewey's point that reflection is a way of learning. Through thirteen notes in Week 9 (See Table 7) the students engaged in reflective activities on the class, its readings, ways of learning, and sharing information, and comments on the role play activity.

Table 7. Reflective Thoughts in the Discussion during Week 9

Participant Category	Note	Main Ideas	Note Category
C	N. 7	Comment on learning in general	Reflection
C	N. 11	Discuss the reading while playing a role	Reflection
C/M	N. 14	Comment on surfing the net and the related jobs	Reflection
C	N. 15	Comment -- can't play a role	Reflection
C/M	N. 9	Encourage debate and role play	Suggestion

Table 7. (continued)

Participant Category	Note	Main Ideas	Note Category
C	N. 19	Reflect on readings in general	Reflection
S	N. 20	Question about technical problems in VaxNotes	Type I Q.
C	N. 23	Reflect on the class (completely frustrating yet intellectually stimulating) Comment on the instructors' summaries and comments made in the previous class Comment on the week's reading (enjoy because of the content familiarity)	Reflection Comment Comment
C/M	N. 24	Comment on learning in the class Comment on the previous class (agree with Note 22)	Reflection
C	N. 25	Reflect on the week's reading and learning	Reflection
C	N. 28	Share experience of young children learning computer games Share experience in high school science class and comment on the science class with Education technology tools (would enjoy more if tools were available)	Reflection Discussion
C	N. 12	Share information on a job related to Education technology	Information Sharing
C	N. 16	Reflect on the class and what has been learned	Reflection

Almost all of these reflections on learning contributed to the discussion, and some students acted as mentors at the same time. Further, they played assigned roles (e.g. optimist, watchdog, speculator, and questioner). Role play activities encouraged other students to be actively involved in the discussion.

Discussion of general learning and thinking skills was another common topic during Week 9 (See Table 8), when about ten individuals discussed these and other related issues.

Table 8. Discussion on General Learning and Thinking Skills during Week 9

Participant Category	Note	Main Ideas	Note Category
C	N. 1	Raise questions about the validity of two studies in weekly readings	Type II Q
C/M	N. 9	Reflect on the history of computing	Reflection
C/W	N. 13	Comment on structured learning vs. unstructured learning	Comment
C/M	N. 14	Comment on tools vs. theories	Comment
C/W	N. 16	Discuss constructivism and tools Raise questions about constructivism	Discussion Type II Q.
C/W	N. 22	Discuss knowledge transfer	Discussion

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Table 8. (continued)

Participant Category	Note	Main deas	Note Category
C	N. 25	Discuss student learning, problem solving, and critical thinking skills	Discussion
C	N. 26	Discuss and raise questions about the nature of learning	Discussion
C	N. 28	Discuss floundering in learning (through playing computer games)	Discussion
C	N. 27	Comment on problem-solver (reply to the previous note)	Comment

They interacted as contributors, mentors, and sometimes wanderers. One of the mentors reviewed the history of computing, providing some background knowledge for a better understanding of how tools evolved to assist learning. The mentor also highlighted the relation and nature of tools and theories, thus supporting students in their understanding of how theories are being used to guide the design of tools. Wanderers contributed to the discussion through the analysis of structured and unstructured learning, constructivism, and tools. They wondered whether these issues related to collaboration, virtual field trips, and others. If they were interconnected, the wanderers had yet to discover these associations. Wandering did not hinder their learning. In fact wandering helped others learn, because the wanderers' notes added fuel to the discussion, created cognitive conflicts, and urged the reader to think. As Piaget would contend, their queries caused other participants to experience disequilibrium and cognitive dissonance which needed to be resolved through additional reflection, discussion, and negotiation.

The following paragraph is a good example of a wandering note in Week 9. It said: "Transfer is important and depth is important. Students have to have opportunities to explore a concept in depth and make transfer from that depth. I think it's the teacher's job to stir that curiosity and that's when the learning becomes relevant, when from a constructionist's viewpoint, you start from the child's prior knowledge. From there you guide them to exploration and transfer and application." This note discussed very generally learning, critical thinking skills, and knowledge transfer without giving or providing any specific references to weekly readings, but instead, it drew heavily from experiences. This note added much food for thought in participant discussions.

Topic Discussions for Week 12. Several major topics of discussion emerged from the discussion of Week 12. They were reflective activities, the issue of using computers with at-risk students, and the issue of software programs that help people think and plan. Four individuals in Week 12 reflected on this distance learning course and the weekly readings. For example, one student wrote: "Once again, I'm excited about the readings for this week. In the beginning of the semester I was intrigued with the technology of education and was at a point of believing that using technology could save our educational system. I really am understanding that technology alone really has no bearing on how someone is able to learn better. It's a very complicated process that I've become more aware of..." Another student wrote: "I would like to say that I am REALLY getting the feeling of this distance thing. As you may not be aware, I am in Syracuse, New York for the rest of the semester .... I won't be in class, but I will be participating in the class discussion in VaxNotes. I can't think of a better class where this situation would be more suitable." (This student was in the hospital during the last month of the semester.) Both students revealed their true feelings towards the course. They started from totally divergent routes but came to a converging point. That is, they felt they had learned a lot from reading and participating in the weekly electronic discussion.

Table 9. Discussion on the Use of Computer Tools with At-Risk Students During Week 12

Participant Category	Note	Main Ideas	Note Category
C	N. 1	Discuss Pogrow's article and raise 3 discussing questions about at risk students	Discussion Type II Qs
C/M	N. 2	Discuss Pogrow's article and argue that the issue is teaching problem- solving skill in general	Discussion
C	N. 3	Share colleague's opinion on simulation	Information Sharing

Table 9. (continued)

Participant Category	Note	Main Ideas	Note Category
C/M	N. 5	Discuss Pogrow's article, agreeing with most ideas except "software as instructional objects...	Discussion
C	N. 6	Discuss Pogrow's article and the approach (both agree and disagree)	Discussion
C/M	N. 7	Discuss Pogrow's article -- drama heightens curiosity and motivation and promotes the emotional engagement that deepens learning.	Discussion
C	N. 8	Comment on Pogrow's article and agree with the starter Disagree with the author on at-risk students learning issue	Comment Discussion
C/M	N. 9	Agree with one previous note -- "general problem solving skills"	Comment
C/M	N. 12	Share experiences working with at-risk students Answer one question from the starter -- "when do we let at-risk students back into the normal classroom?"	Information Sharing Answer
C	N. 16	Discuss Pogrow's article -- 1) how instructors use software; 2) software and tools are not answers to education problems; 3) creative use of tools	Discussion
C	N. 17	Discuss the readings -- drama, visualization, creativity	Comment
C	N. 18	Summarize different comments on Pogrow's article	Discussion
C	N. 20	Discuss Pogrow -- "sophistication of the learning produced by technology, depends on the sophistication of the conversation surrounding its use, not the sophistication of the technology." Discuss Pogrow's emphasis on meta-cognition	Discussion
C/M	N. 22	Discuss meta-cognition Discuss at-risk students -- "at some time/different time we are all "at risk".	Discussion Type II Qs

During Week 12, fourteen individuals engaged in a lively sub-discussion about computers being used with at-risk students. They shared information and personal experiences regarding working with at-risk students, and discussed the author's approach to at-risk students. Some answered an information seeking question. Some analyzed the nature of software used with at-risk students and problems with at-risk students. Others challenged the author's approach to at-risk students and the class by saying that "... at some time/different time we are all 'at risk'." Finally, some mentors suggested that other students should think about teaching general problem-solving skills with at-risk students because problem-solving skills are essential to all learners.

Table 10. Discussion on Software That Helps People Think Creatively and Plan Effectively during Week 12

Participant Category	Note	Main Ideas	Note Category
C	N. 1	Discuss Schorr's article and raise 4 questions	Discussion Type II Qs
C/M	N. 2	Discuss Schorr's article, commenting that IdeaFisher would limit creativity more than it could increase it. ... Inspiration allows for more creativity...	Discussion
C	N. 3	Discuss IdeaFisher and argue that every piece of software could be an interpretive work at some level.	Discussion
C	N. 6	Provide answer to one of the starter's question -- "do we need a computer to develop these types of thinking strategies?"	Discussion Answer
C	N. 8	Comment on Schorr's article, enjoying Inspiration	Comment
C/M	N. 9	Discuss Schorr's article from special education point of view Agree with one previous note -- "the effect of the IdeaFisher lies in the inspiration created by effective brainstorming"	Discussion Comment
C	N. 16	Discuss Schorr's article, Inspiration, and Widget	Discussion
C	N. 17	Discuss Schorr's article and agree with the starter (article carries a sale pitch) but personally like software help create ideas	Comment
C/M	N. 19	Discuss Writing Partner	Discussion Scaffolding

About 10 students in Week 12 engaged in a discussion of tools that help people think creatively and plan effectively. The discussion revealed individual opinions as well as a common thread--how can tools help people think creatively and plan. For example, one student wrote: " I thought that IdeaFisher would limit creativity more than increase it. Doesn't this tend to destroy our own creativity and turn us into lazy couch potatoes?". Another student voiced the opposite opinion: "You use this word (here it refers to 'potato') as a springboard to idea generation. This method sounds similar to the word list in IdeaFisher. It really doesn't limit you in terms of creative thinking any less than brainstorming. In fact, it opens you up because it forces you to find a way to use a word like 'potato' to generate ideas about a problem you'd like to solve."

One student said: "I thought that Inspiration allowed for more creativity since the tool did not prod or lead the learner." Another student echoed: "I believe that everyone is in need of such a program--Inspiration. Everybody would like to find some sort of help when it comes to arranging ideas. The visual presentation of one's thoughts, rearranging them in order to create his/her own ideas, changing relationships and so forth makes this tool indeed impressive in my view."

Opinions on computer programs that help people think creatively and plan effectively were quite diverse. The notes demonstrated personal preferences for certain programs and also revealed both excitement and doubts about tools that can help people think and plan. To further assist students' discussion about tools and understanding of how they worked, some of these tools were later demonstrated in class.

Summary of Discussions in Week 9 and 12. The analysis showed that four major discussion topics emerged from the readings and were discussed at length during Week 9. They were: 1) general discussion on the nature of learning, critical thinking skills, problem solving skills, etc.; 2) discussion of tools for collaborative learning; 3) the issue of relevancy in the use of computers; and 4) reflections on the class and weekly readings. In Week 12, four major themes or threads ran through the discussion: 1) general discussion on thinking skills and technological tools for learning; 2) reflections on the class, readings and learning; 3) discussion of tools, such as IdeaFisher, Inspiration, and Writing Partner that help people think creatively and plan effectively; and 4) discussion of tools and their uses in special education.

The analysis of two weeks' discussions revealed that almost all students were contributors and the instructors were mentors during electronic discussions. The notes were mostly in the categories of discussion, comment, reflection, information sharing, and scaffolding (See Table 11). There were only two type I questions (e.g. What does it mean by "share space"?). The interaction type during the two weeks' discussions was predominantly horizontal.

Table 11. Summary of Note Category, Participate Category, and Interaction Type in Week 9 and Week 12

Note/Participation Category [*]	Week 9	Week 12	Interaction Type
Type I question	1	1	Vertical
Type II question	4	10	H
Discussion	23	30	O
Answer	0	4	R
Information sharing	2	4	I
Comment	16	14	Z
Reflection	6	2	O
Scaffolding	4	8	N
Contributor	46	43	T
Wanderer	1	4	A
Mentor	22	8	L
Seeker	0	1	Vertical

RESULTS AND DISCUSSION

Patterns of Electronic Discussion

The analysis has shown some interesting patterns in the discussion. First, the electronic discussion usually centered around some major themes emerging from the weekly readings. For example, in Week 9, six notes discussed cognitive tools and the relevancy of tools used in learning. However, the analysis has also shown that having one discussion topic covered by a group of students' notes does not eliminate the divergence and diversity of the discussion. That is, though each note was discussing the same topic, each perspective was quite idiosyncratic and based on the individual's understanding and experiences. To illustrate this point, consider Note 5 and Note 6 in Week 9. Note 5 was responding to Note 1 and discussed the issue of tools relevancy and so was Note 6. However, Note 5 wrote:

> "Anderson's article on Medical Center gives us the notion of how learning is facilitated by higher order of thinking. The issue that Student A brought forward regarding the concept of transferability of information and relevancy is good. In order for the software to be relevant, it has to set goals. One of the goals in designing Medical Center is to give learners the opportunity to build a schema and relate content knowledge to its application in clinical problem solving."

Note 6 wrote:

> "I think relevancy is what the teacher's role is and also how teachers make the specific tools relevant to their course and learning in general. The process of problem solving is a very important goal in any course (just look at the Indiana standards for public education). I admit the context that the Medical Center program and the Envisioning Machine is not relevant to every subject, but the process of problem solving that these individual subjects teach can be applied to all areas."

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[*] Most notes comprised of several paragraphs and each paragraph was usually devoted to the discussion, comment, and reflection of one idea. Thus, a note can fall into several categories.

The convergence on the major discussion themes did not limit the depth of discussion or the understanding; on the contrary, it brought multiple perspectives to the topic under discussion, thereby providing an extremely rich context for students to construct their individual understanding of the issue.

Secondly, this electronic media supported both the vertical and the horizontal interactions. The participants were at some time equal peers, but other times a few peers acted as guides or mentors for other students' learning. For example, one student in Week 6 wrote:

> "We all seem to be concerned with what technology will *do* to us. Will it improve our thought processes? Will it stunt our creativity? Will it augment or hinder our collaboration? I think there's a danger in giving so much agency to technology. We have to remember where tools come from. They come from our minds. So, tools might be catalysts for improvement of our thought processes, but the agent of change is ourselves."

This student's note reminded the class of a very important idea that tools should be extensions of ourselves, not replacements of ourselves or agents to direct our relationships to learners. We should bear this in mind when we incorporate tools into instruction. Notes like this may have contributed more to the discussion due to their meaning and importance. Accordingly, these students contributed more to that particular discussion topic than to others. Across the weekly discussion, there were participants who raised questions and asked for answers and others who actively shared, exchanged, and constructed new ideas and concepts. Both types of interaction in the discussion were conducive to knowledge construction.

Many researchers (Rogoff, 1990; Wertsch, 1985) influenced by Vygotsky have studied vertical interaction (represented by adult-child interaction). A current learning model, apprenticeship (Collins, Brown, & Newman, 1989) is also concerned with interaction that is vertical in nature; however, other researchers argue that the construction of knowledge through social interaction can be observed much more often in horizontal interaction (peer interaction) (Hatano & Inagaki, 1991). We observed the same phenomena in the distance learning course. The horizontal interaction appeared much more often than the vertical interaction. The role each member assumed was not fixed or permanent, but could be switched and interchanged with ease. The interaction in the discussion moved naturally and smoothly on the interaction continuum rather than jumping from one end to the other. That is, the vertical-horizontal interaction can be seen as a continuum rather than a dichotomy (Hatano & Inagaki, 1991).

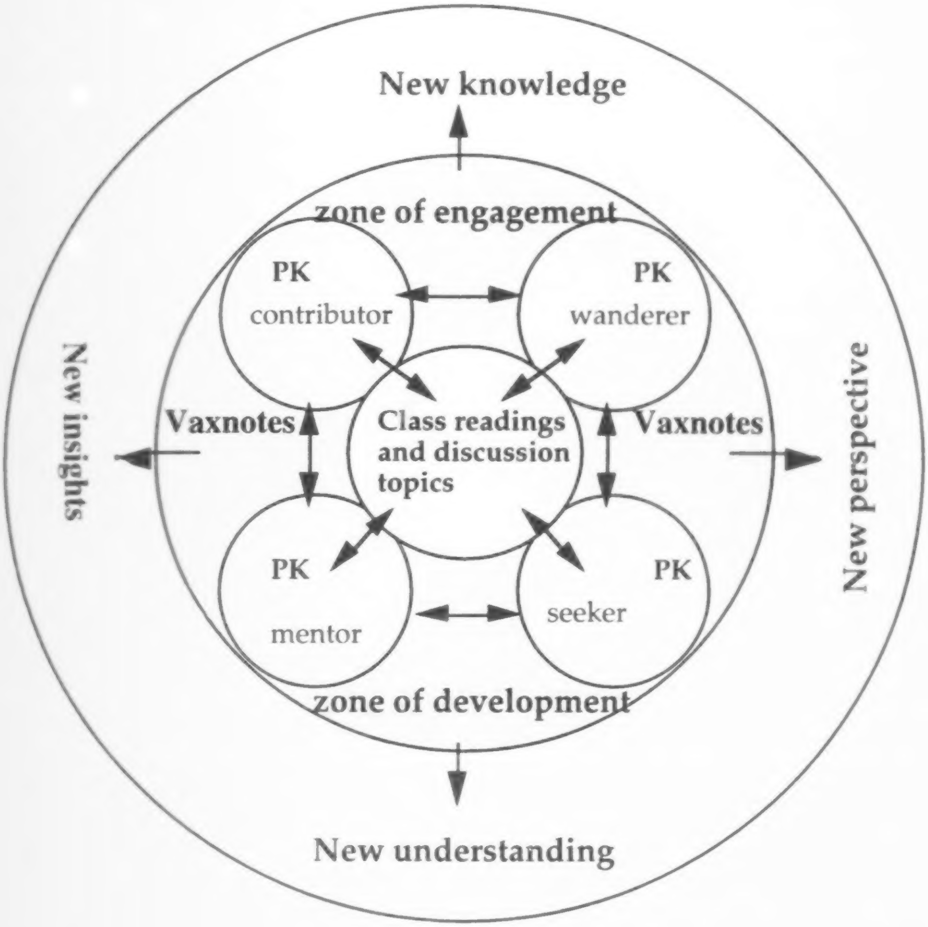
Third, the electronic discussion was apparent within everyone's zone of engagement, therefore everyone was engaged in the discussion, rather than just a few students. As the analysis has shown, the number of contributors was in appropriate proportion to the number of notes each week. Most students contributed once or twice each week. Few students contributed more than twice. Peers' thoughts and notes usually created cognitive conflicts or perturbation in the students and urged them to think and to act. Therefore, VaxNotes provided a space for every student to engage in thinking, acting, expressing ideas, and interacting with peers. Moreover, VaxNotes served as an excellent place for them to work within their zone of proximal development (ZPD) with the assistance from peers and instructors. While working within their own ZPD with the help of the instructors and peers, the students settled many cognitive conflicts and perturbations, thereby maximizing cognitive growth and development.

Pattern of knowledge construction in the electronic discussion

The electronic discussion in VaxNotes is viewed as the zone of engagement and development (See Figure 1) in which every member of the class can participate, express or exchange views, and actively engage in constructing a better understanding of issues based on his prior knowledge and current understanding.

Figure 1

Pattern of knowledge construction in the electronic discussion


New knowledge
zone of engagement
PK
contributor
PK
wanderer
New insights
Vaxnotes
Class readings and discussion topics
Vaxnotes
New perspective
PK
mentor
PK
seeker
zone of development
New understanding

Note:

The core (inner circle) is the location of discussion topics .

The shaded circle (middle circle) contains the zones of engagement and development.

The white circle (outer circle) is where students construct new knowledge, understanding, insights, and perspectives.

The participant category circle is the embedded white circle with the abbreivation of PK (Prior knowledge).

In Figure 1, the construction of knowledge starts from the core, that is, the inner circle--weekly discussion topics and readings. Surrounding the inner circle is the discussion space (the shaded middle circle)--the zone of engagement and development where each individual was involved. After numerous trips between the inner circle and the middle circle, and various interactions with equal and superior peers and instructors, the student finally arrives at the outer circle wherein he/she constructs new knowledge and understanding. The assistance from instructors and peers and the interaction among them are crucial to learning and knowledge construction (Gallimore & Tharp, 1990). The constant trips and interactive relationships are represented by bi-directional arrows used between the inner circle and the middle circle and among categories of participants within the shaded middle circle. In the electronic discussion, the student and the instructor may assume the roles of contributor, wanderer, information-seeker, and mentor. As indicated, the role of each individual is by no means permanent or exclusive. The student can assume several different roles or shift roles in one electronic note. The bi-directional arrows between each role depicts the interchangeable and interactive nature of a role.

According to this model, a student reads weekly assignments, discusses them in the electronic space, and reads other students' notes. When moving back and forth between the inner circle and the middle circle--from reading and discussing, the student brings prior knowledge and experience. The activities of reading and discussing are highly integrated so that the student may read one article at one moment and in the next minute may post thoughts in the electronic conference or read notes from other students. Embedded in these activities are a series of other learning activities such as sharing information, requesting answers, reflecting, and commenting. Thus, while engaging in such activities, the student also is assuming the responsibility to plan, monitor, motivate, and regulate learning. Exercising such metacognitive skills has received increasing attention by educators and researchers (Paris & Winograd, 1990).

The formation of a plan, goal-setting, and other activities are socially and cognitively regulated by the interaction with peers and instructors. From Vygotsky's (1985) point of view, the student is moving between the interpersonal plane (social plane) and the intrapersonal plane (psychological plane) in the electronic discussion, because activities such as planning, monitoring, and self-regulating have to happen on both planes. In other words, the individual's cognitive development is not attributed to the individual alone but has its origins in social groups such as the large and small discussion groups in our electronic discussions. The student has to adjust and re-define learning activities through interactions with peers and instructors. In our case, the notes contributed by each individual urge other students to re-examine their learning goals and objectives. These notes in the discussion also create cognitive conflicts for any future reader. In other words, social interaction serves as a stimulus for individual cognitive growth.

Though knowledge construction and acquisition share the same pattern among students in the electronic discussion, differences do exist even among those who are actively involved in the same discussion. The acquisition of new knowledge and understanding will not be equal across the board. It depends on the amount of activities in which the individual is engaged in, the effort invested, and on his or her prior knowledge. While the major pattern of knowledge construction in the electronic conference is similar (i.e. starting from the inner circle and arriving at the outer circle as illustrated in Figure 1), the sub-process each individual engages in may differ. Two possible processes could be identified in the knowledge construction in the electronic discussion: a) individual construction of knowledge motivated, influenced, and facilitated by the discussion and the interaction with peers; and b) assimilation of information proposed by others with some individual editing. The more active students are, the more likely they are to go through the first process and the less active students engage in the second process.

Electronic Discussion Organization

As indicated earlier, the organization of the electronic discussion consists of four major components: the starter, the wrapper, the introductory questions and advice from the instructor, and participant comments. A good starter usually pointed to a few major discussion themes for a weekly discussion. However, using a wrapper for each week did not reveal many educational advantages. In fact, most students simply ignored the wrapper. The reason may be that the summary of one's learning can be quite individual. When a student has gone through a week's discussion, he/she needs to think or reflect himself/herself about what and how is learned. There will be little or probably no commonality in the way each individual summarizes or concludes at the end of a weekly discussion. No individual's wrap-up can be so comprehensive and exhaustive as to include and represent the ideas of the entire class. From this perspective, the role of wrapper does not function as successfully in the electronic discussion as is expected.

The instructor's introductory questions served as exemplary guides to the discussion. However, the students usually did not set the discussion around those questions, nor did the instructors endeavor to lead the discussion around the questions. The reason for this could be that: 1) students do not see any close relationships between the readings and the questions posted; 2) the students feel more restricted in the discussion if they follow the questions; 3) the questions

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are too broad to focus on; and 4) the instructors do not have the adequate mechanisms to lead the discussion towards the questions. Questions in Week 7 and Week 10 could explain one point here. The instructor posed such introductory questions for Week 7: "Why is information access so important? Can we teach search skills?" For the discussion in Week 10, one introductory questions was: "Is there any difference between tools, tutors, and multimedia word problems?". These questions were very broad and hard to focus on given no further guidance.

Though the organization of the electronic conference was conducive to discussions and effective in facilitating learning, much could be improved. First of all, after assigning the role of the starter and the wrapper, mechanisms could be invented to constantly monitor the implementation of roles and to revise them if necessary. Secondly, in addition to the role of the starter and the wrapper for the weekly discussion, volunteer students could be recruited each week to serve as extra facilitators and mentors during the discussion. The instructors could have paired up some advanced students with new students and let them serve as mentors to the new students. When in a pair or a small group, advanced students could more accurately diagnose the new students' skill and understanding levels, thereby providing them with appropriate information, sharing experiences with them, and helping them better understand the issues. The advanced students could serve as a bridge enhancing the link between instructors and the new students. While these students are still novices compared to the instructor, they are perceived as experts by the new students. They could play dual roles--help themselves as well as fellow students to learn. If the advanced students in the class were taking dual roles, more of students' learning could be guided and consequently their involvement in the discussion could be more meaningful, and their learning more successful. Lastly, the introductory questions for the discussion could be more issue-based to give students more latitude in developing their own ideas and thoughts. Meanwhile, it could draw them to central issues and thus be easy for the instructors' guiding and scaffolding.

Roles of Students and Instructors

Students' role. The use of VaxNotes and its discussion has reconfigured the role of the student and the instructor in this distance learning course. Students in this class were actively involved in their own learning through such activities as planning, self monitoring, and self-regulating. What the instructor provides here was reading materials, insights, and an electronic conferencing tool. It was left to the students to decide how to take advantage of the tool (i.e., VaxNotes), the electronic resources, and assistance from the instructors. Students decided how to participate in the discussion, how to learn, and what to learn. Learning was centered around students and thus they had more control over their own learning. Some students enjoyed using VaxNotes as a tool to engage in the discussion because they believe the action of writing down their ideas makes them think and reason more deeply and clearly. Our survey indicated that students believe that through this electronic conferencing they learn more about the subjects and about the peers; everyone is participating, even the most shy students whose perspectives and voices are usually absent in face to face discussion. For example, one student said: "Surely, using VaxNotes or news groups or even email has a big advantage, that is, for shy and foreign students whose first language is not English, this is a very good place to express their opinion."

Instructors' role. The role of the instructor has been reconfigured just as the role of the student has been. The instructor is no longer a knowledge dispenser or a lecturer who preaches without listening to students' input, understanding, and interpretation of the readings. Instead, in this course the instructor was the mentor and the facilitator of students' learning. The instructor read students' notes, interacted with them, assessed their understanding, and thus provided guidance for their understanding and learning. For example, in Week 6, one instructor explained the notion of shared space: "Shared space is the place where you can go to communicate and you and others can come back to it and review it. With technology, shared space makes thoughts and ideas visible through email or a bulletin board system like VaxNotes. ... If you and I were working on a paper and you left a copy of it on the network, then the file it is stored under is our shared space. It is a place we can go to when conversing and reflecting on that conversation."

The task of guiding students' learning is no easy job. In the course, the instructors invented several ways to guide students' learning. The methods of guidance used in the electronic discussion are quite successful on the whole. Most students expressed positive feelings towards the electronic discussion and their learning in the class. One student wrote:

> "I admit that I dread coming to the lab to post notes and reflections about the articles and class discussion. However, like Julie, I recall times in class when there was something I wanted to discuss but for one reason or another, the point was forgotten. Using electronic classrooms as the primary means for discussion would allow us to explore ideas in depth and several ideas at the same time. Students who have a difficult time

> following the class discussions have a chance to catch up. The electronic classroom gives them a tool for reflection and clarification about class discussion. Students may not feel as apprehensive about discussing. That is a tool that benefited all of us."

Three methods of guidance have been invented and implemented with relative successes and failures. First of all, the instructor designed the roles of the starter and wrapper to facilitate the electronic discussion. Also, the introductory discussion questions were meant to guide students' discussion; however, most students disregarded the questions because "they are too hard, long, and difficult to follow."

A second method instructors employed to guide and scaffold students' learning was to build upon students' notes. During the discussion, the instructor added comments to generate more conversation, pushed students to defend their opinions, and answered students' information seeking questions. Of course, due to the larger number of students in class, it was extremely hard for the instructor to meet every student's learning and needs. Some students felt that instructors could add more of their experiences and thoughts about the readings and could answer or comment more on the questions raised by students. Sometimes, they expected less. For example, one student wrote: "I'd like for the comments to be less all-encompassing. Just a nudge here or there would be fine. What the instructor says tends to be taken as the final word on an issue, thus it can stifle conversation." Another student expressed the opposite view: "... I think instructor should pay more attention to lead the discussion and make sure everyone catch the points."

Finally, the instructors utilized the method of role play during the electronic conference. Each student was given a role or could choose one. Some students assumed the role play very well and motivated other peers to contribute more. However, the role play method was not well accepted by some other students, because of their personal learning style. They simply felt that they could not discuss and assume one of the roles simultaneously.

CONCLUSION_

This study reveals a promising way of employing a piece of ordinary communication technology to facilitate students' learning and has proven to be quite successful. In the electronic discussion, students selected topics, determined their goals, shared experiences and understanding with peers. Meanwhile, they tried to make sense of the issues and the concepts through reading articles and working within their own ZPD with the assistance from instructors and peers. VaxNotes is a "shared space" wherein students can engage in various collaborative learning activities. This is a social and intellectual tool for facilitating understanding and supporting the social construction of knowledge.

The study has reported some pioneering efforts in using computer mediated communication tools in instruction. More empirical research should be conducted to verify the participant and note coding schemes and models of analysis used here. More studies need to be conducted to establish practical guidelines for incorporating computer mediated tools into classrooms, because before one can begin to look at effective implementation of a new technology, one must understand how that technology can be used both mechanically and pedagogically. The field is promising and wide open to researchers from many disciplines.

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APPENDIX A

Figure A
Personal Interests Continuum

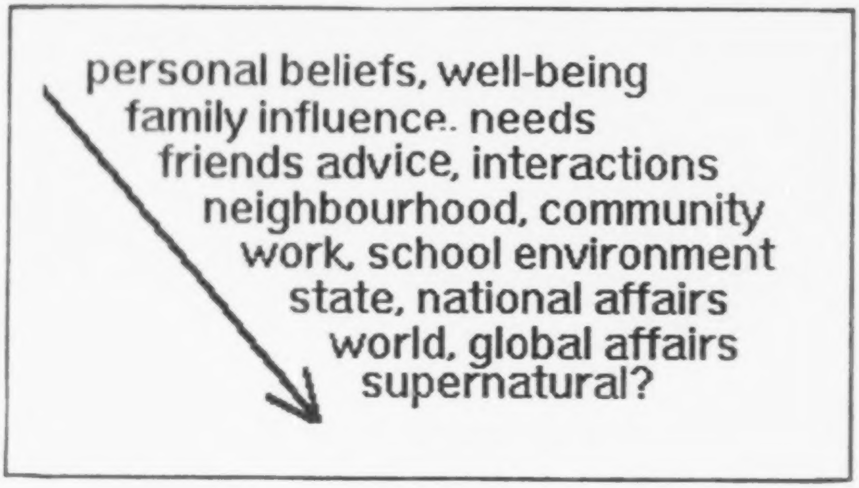
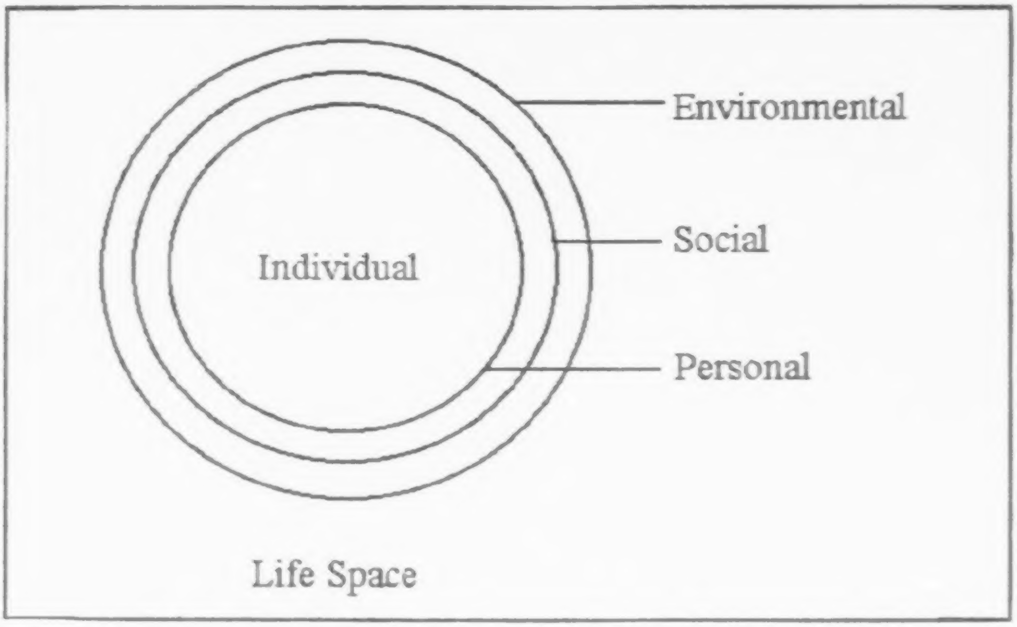

personal beliefs, well-being
family influence, needs
friends advice, interactions
neighbourhood, community
work, school environment
state, national affairs
world, global affairs
supernatural?

Figure B
Lewin's Visualization of the Life Space of an Individual


Environmental
Social
Individual
Personal
Life Space

APPENDIX B

Table 1. Research question, data sources, and methods

Research Question	Data Gathered	How Obtained	When	Who
1. Does metacognitive knowledge affect the strategies employed?	Written responses to several questions	Pre-Search Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-search Question.	Post-search	Participant
	Verbal responses to several questions	Stim. Post-Search Inter.	Post-search	Participant and Researcher
2. Are perceptions of disorientation influenced by the strategies employed?	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-Search Question.	Post-search	Participant
	Verbal responses to several questions	Stim. Post-Search Inter.	Post-search	Participant and Researcher
3. Does perceived self-efficacy affect the strategies employed?	Written responses to several questions	Pre-Search Survey	Pre-search	Participant
	Written responses to several questions	Post-search Ques.	Post-search	Participant
	Verbal responses to several questions	Stim. Post-Search Inter.	Post-search	Participant and Researcher
4. Does system knowledge affect the strategies employed?	Written responses to several questions	Pre-Search Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant

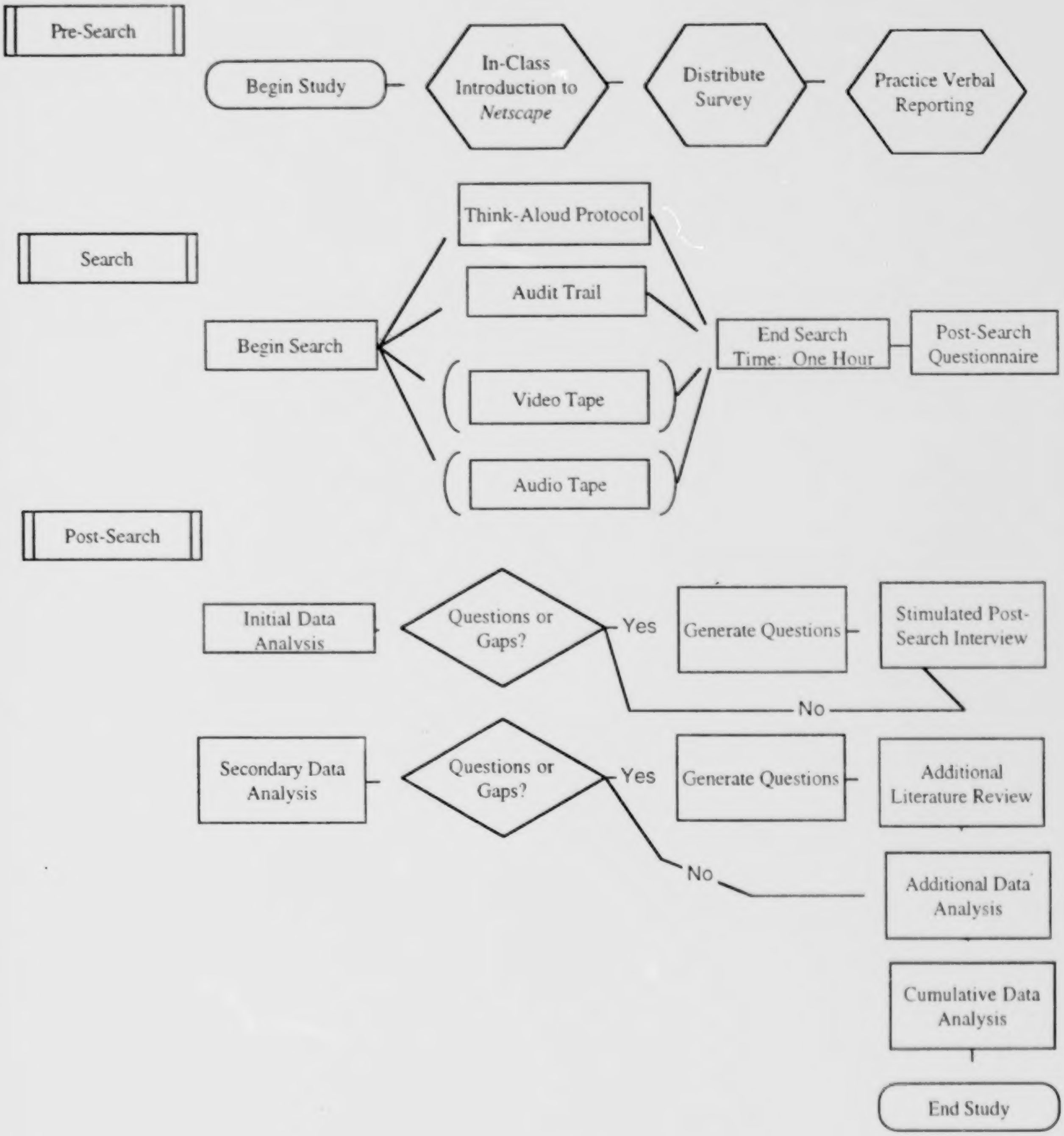
Table 1 -- continued

Research Question	Data Gathered	How Obtained	When	Who
4. Does system knowledge affect the strategies employed?	Written responses to several questions	Post-search Questionnaire	Post-search	Participant
	Verbal responses to several questions	Stimulated Post-Search Interview	Post-search	Participant and Researcher
5. Does subject knowledge affect the strategies employed?	Written responses to several questions	Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-search Questionnaire	Post-search	Participant
	Verbal responses to several questions	Stimulated Post-Search Interview	Post-search	Participant and Researcher
Overall Question: What strategies are employed in open-ended hypermedia information systems?	Written responses to several questions	Survey	Pre-search	Participant
	Protocol	Think-Aloud Protocol	Search	Participant
	Audit Trail	Video tape	Search	Participant
	Written responses to several questions	Post-Search Questionnaire	Post-search	Participant
	Verbal responses to several questions	Stimulated Post-Search Interview	Post-search	Participant and Researcher

Table 2. Summary of participants reported knowledge, overall ranking, and "success"

Participant	Metacognitive	Disorientation	Self-Efficacy	System	Subject	Overall Ranking	"Success" Rating
Alyssa	mid	high	low	low	mid	low	no
Bill	high	mid	mid	low	mid	mid	yes
Marsha	low	mid	mid	low	low	mid	no
Mick	high	low	high	low	high	high	yes

Figure 1. Study Activities


Pre-Search
Begin Study
In-Class Introduction to *Netscape*
Distribute Survey
Practice Verbal Reporting
Search
Think-Aloud Protocol
Audit Trail
Begin Search
Video Tape
Audio Tape
End Search Time: One Hour
Post-Search Questionnaire
Post-Search
Initial Data Analysis
Questions or Gaps?
Yes
Generate Questions
Stimulated Post-Search Interview
No
Secondary Data Analysis
Questions or Gaps?
Yes
Generate Questions
Additional Literature Review
No
Additional Data Analysis
Cumulative Data Analysis
End Study

APPENDIX C

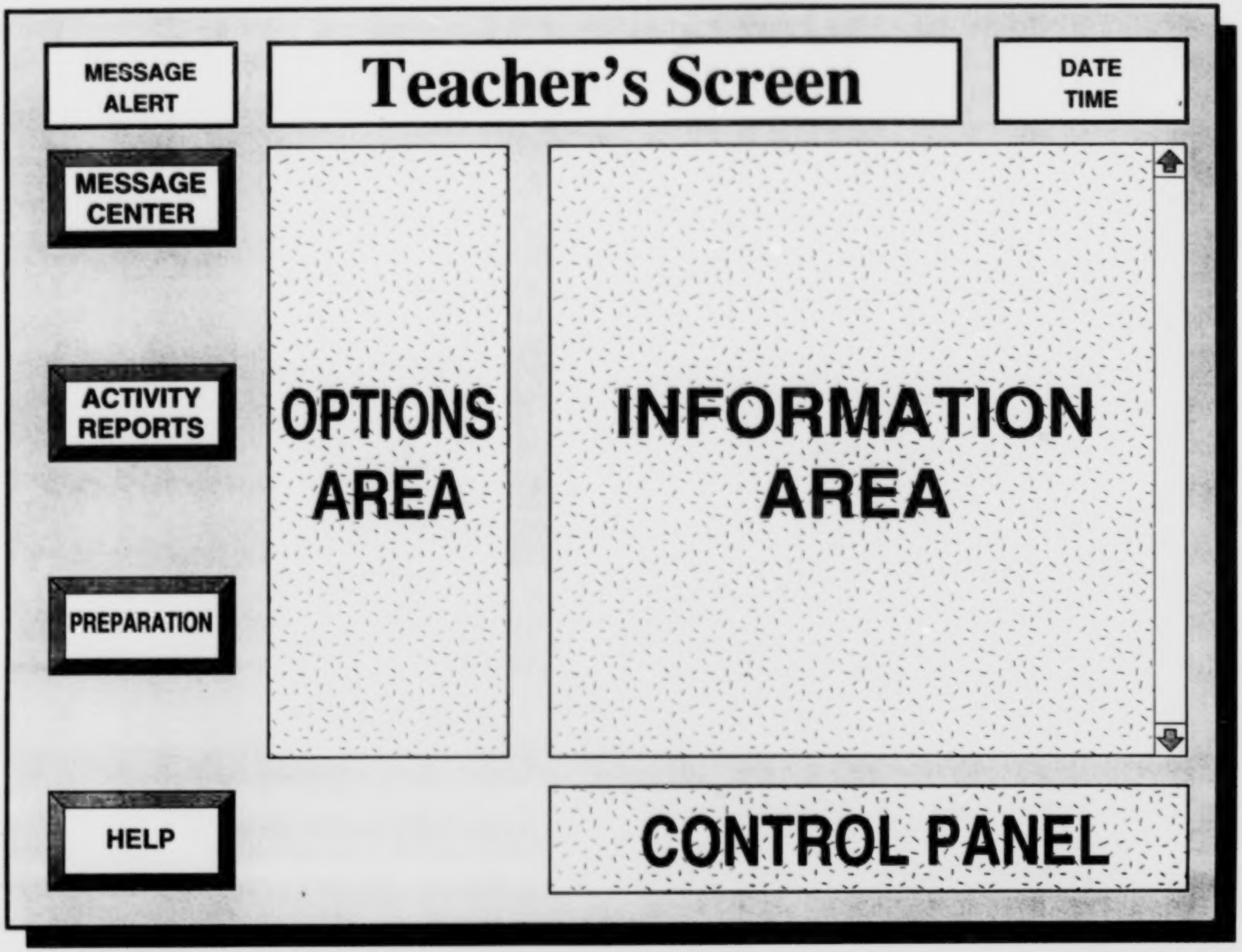
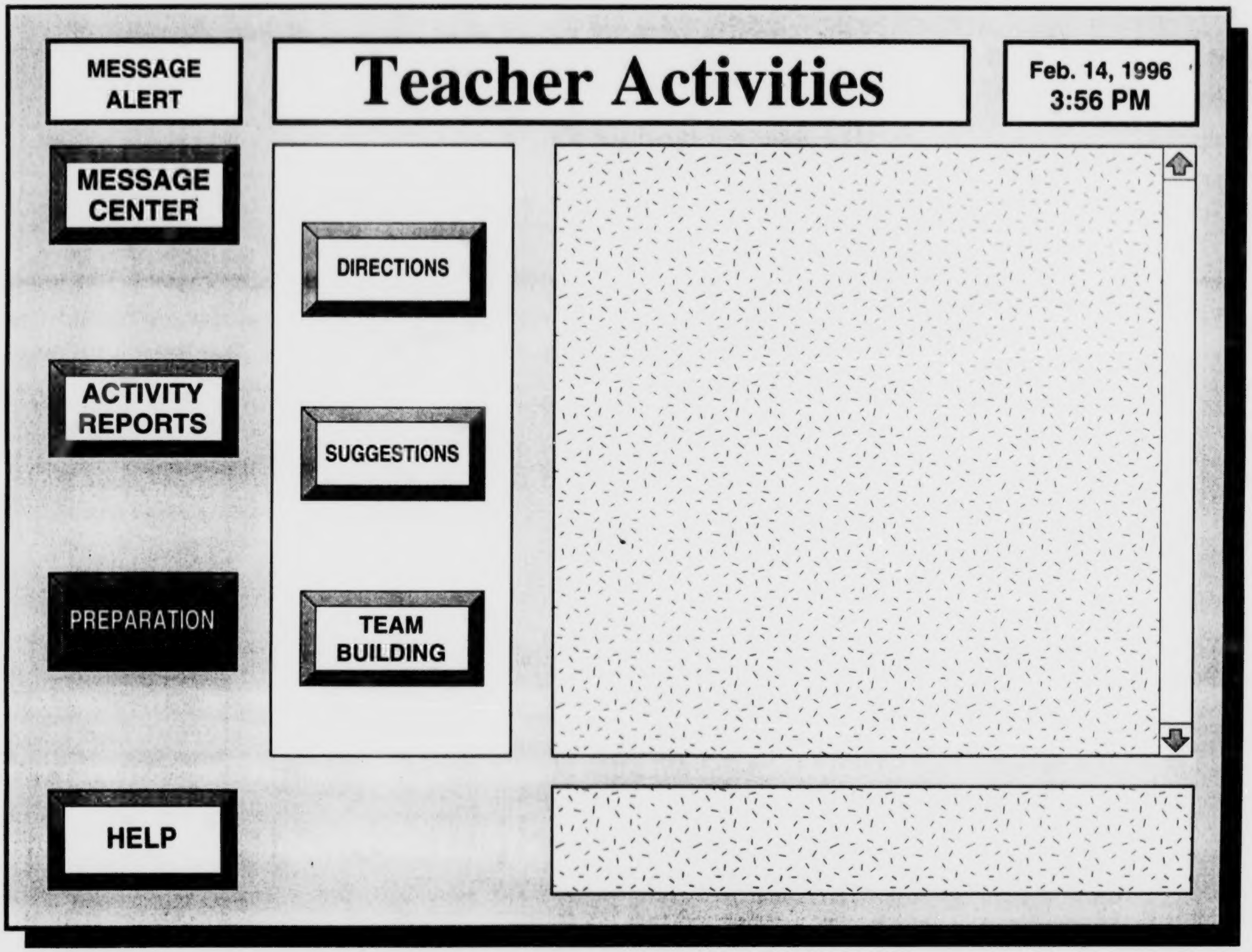

MESSAGE ALERT
Teacher's Screen
DATE TIME
MESSAGE CENTER
ACTIVITY REPORTS
PREPARATION
HELP
OPTIONS AREA
INFORMATION AREA
CONTROL PANEL

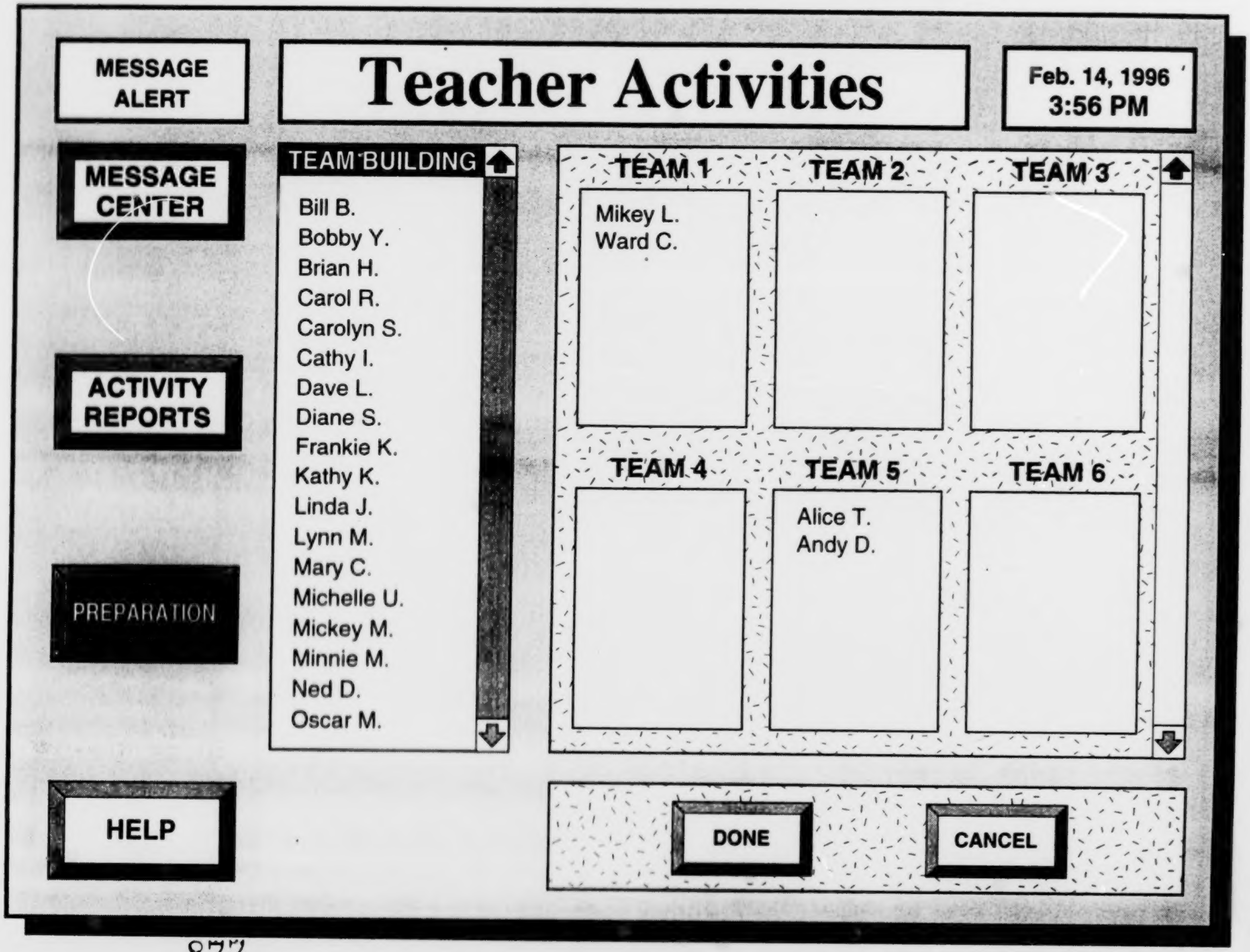
Figure 1.



MESSAGE ALERT
Teacher Activities
Feb. 14, 1996
3:56 PM
MESSAGE CENTER
DIRECTIONS
ACTIVITY REPORTS
SUGGESTIONS
PREPARATION
TEAM BUILDING
HELP

875

Figure 2.


MESSAGE ALERT
Teacher Activities
Feb. 14, 1996
3:56 PM
MESSAGE CENTER
ACTIVITY REPORTS
PREPARATION
HELP
TEAM BUILDING
TEAM 1
TEAM 2
TEAM 3
TEAM 4
TEAM 5
TEAM 6
DONE
CANCEL
877
878

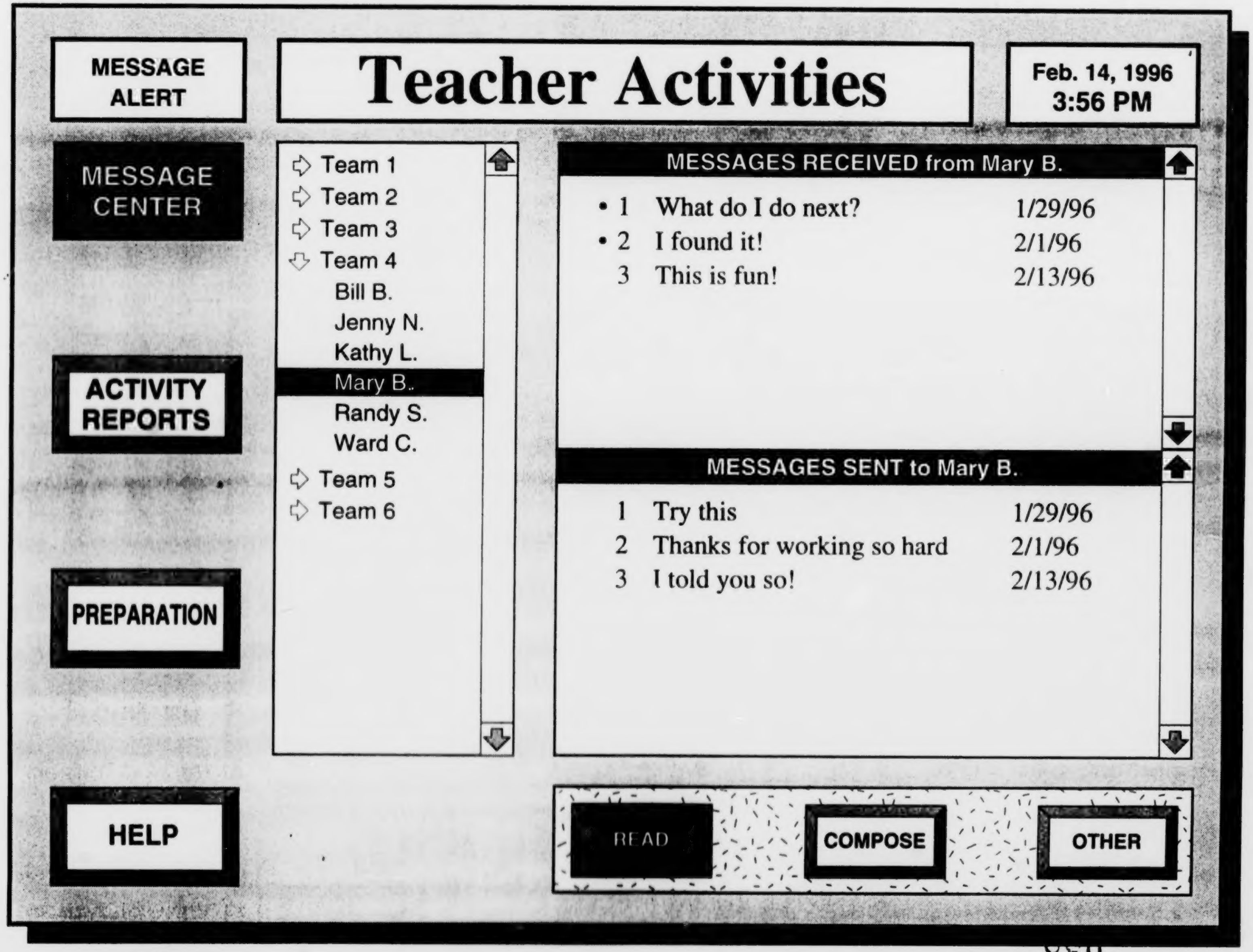
Bill B.
Bobby Y.
Brian H.
Carol R.
Carolyn S.
Cathy I.
Dave L.
Diane S.
Frankie K.
Kathy K.
Linda J.
Lynn M.
Mary C.
Michelle U.
Mickey M.
Minnie M.
Ned D.
Oscar M.

TEAM 1: Mikey L.
Ward C.

TEAM 5: Alice T.
Andy D.

C3

Figure 3.


MESSAGE ALERT
Teacher Activities
Feb. 14, 1996
3:56 PM
MESSAGE CENTER
ACTIVITY REPORTS
PREPARATION
HELP
Team 1
Team 2
Team 3
Team 4
Bill B.
Jenny N.
Kathy L.
Mary B..
Randy S.
Ward C.
Team 5
Team 6
READ
COMPOSE
OTHER
879
880

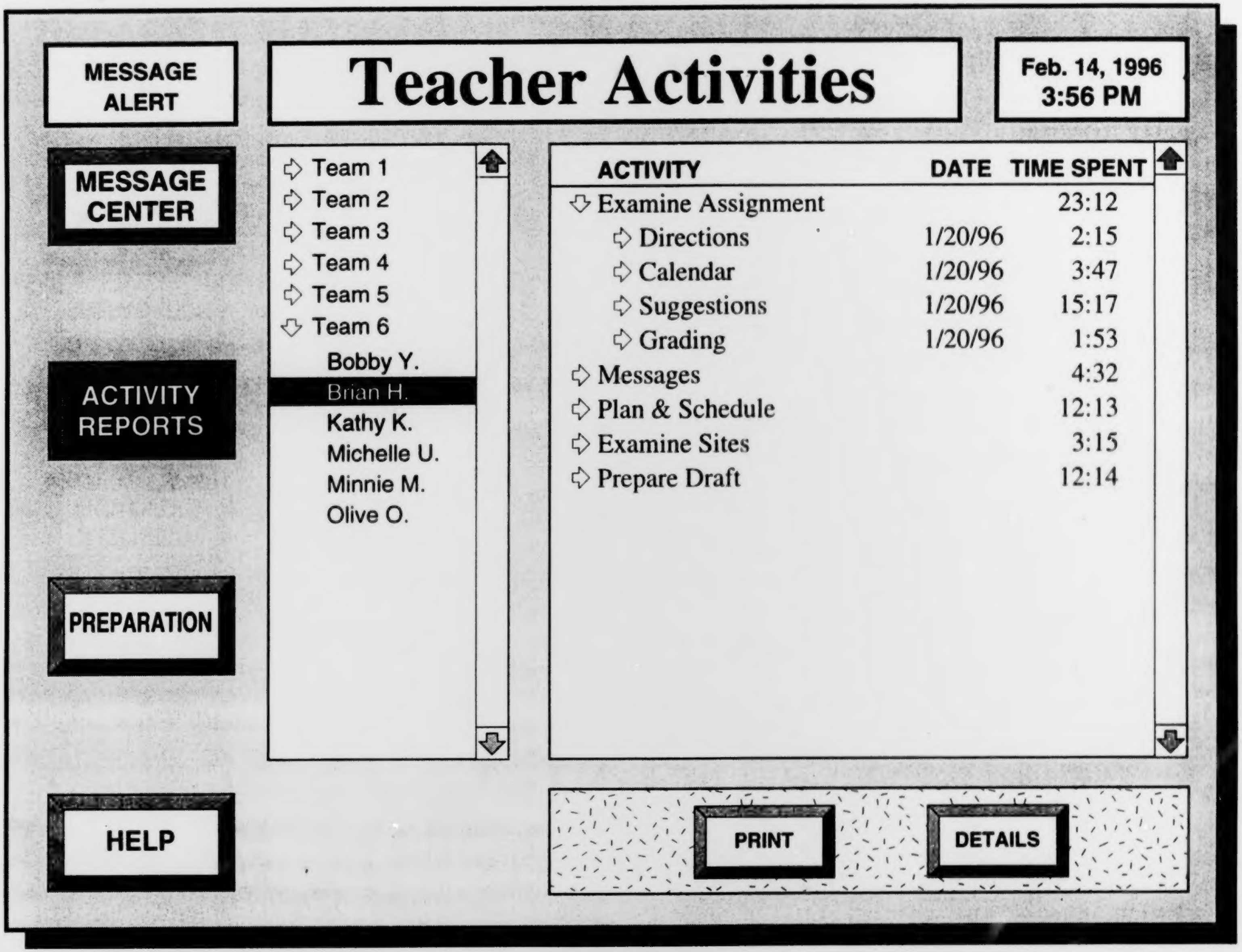
MESSAGES RECEIVED from Mary B.

•	1	What do I do next?	1/29/96
•	2	I found it!	2/1/96
	3	This is fun!	2/13/96

MESSAGES SENT to Mary B.

1	Try this	1/29/96
2	Thanks for working so hard	2/1/96
3	I told you so!	2/13/96

C4


MESSAGE ALERT
Teacher Activities
Feb. 14, 1996
3:56 PM
MESSAGE CENTER
ACTIVITY REPORTS
PREPARATION
HELP
PRINT
DETAILS
881
882

- ⇨ Team 1
- ⇨ Team 2
- ⇨ Team 3
- ⇨ Team 4
- ⇨ Team 5
- ⇩ Team 6
  - Bobby Y.
  - Brian H.
  - Kathy K.
  - Michelle U.
  - Minnie M.
  - Olive O.

ACTIVITY	DATE	TIME SPENT
⇩ Examine Assignment		23:12
⇨ Directions	1/20/96	2:15
⇨ Calendar	1/20/96	3:47
⇨ Suggestions	1/20/96	15:17
⇨ Grading	1/20/96	1:53
⇨ Messages		4:32
⇨ Plan & Schedule		12:13
⇨ Examine Sites		3:15
⇨ Prepare Draft		12:14

Figure 5.

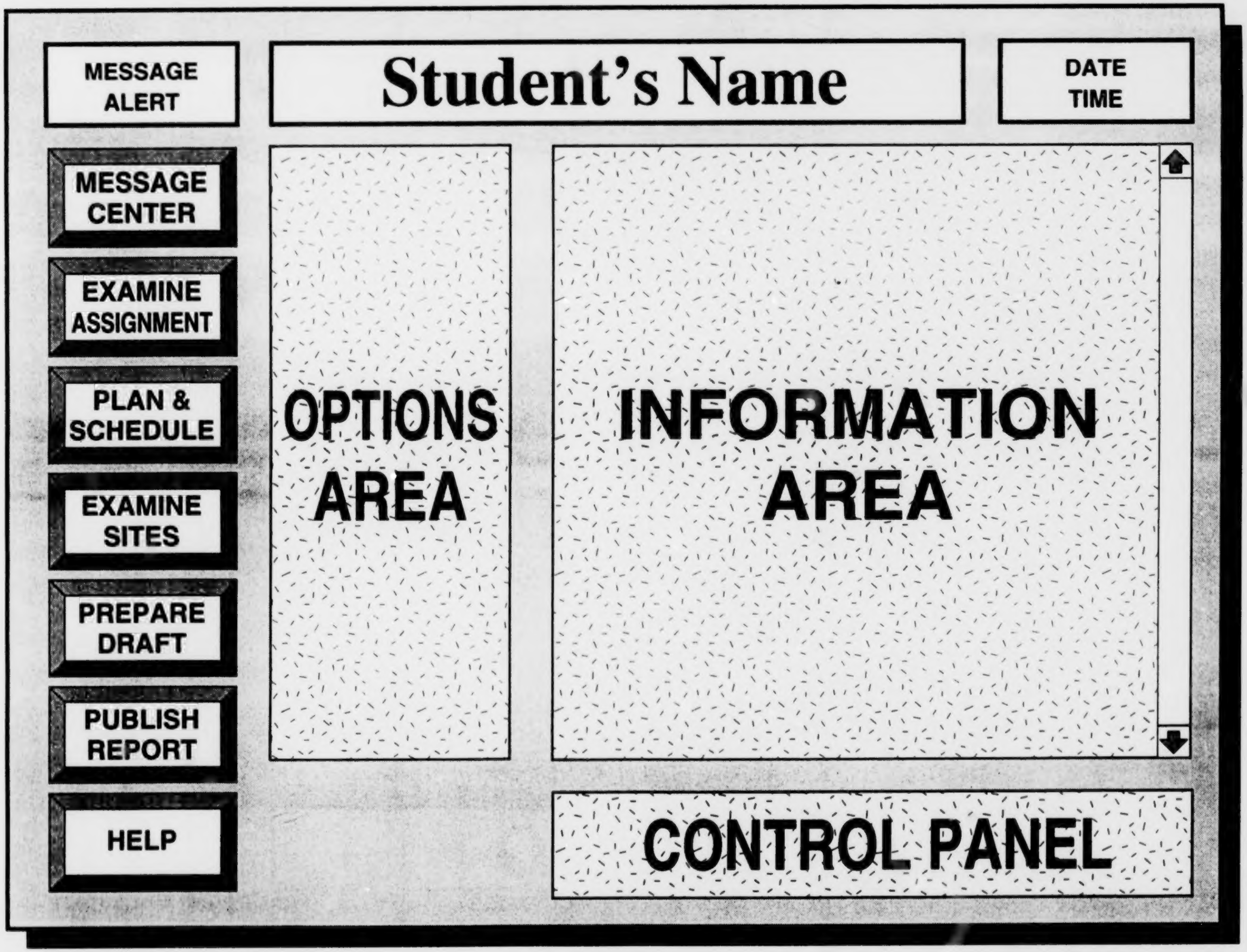
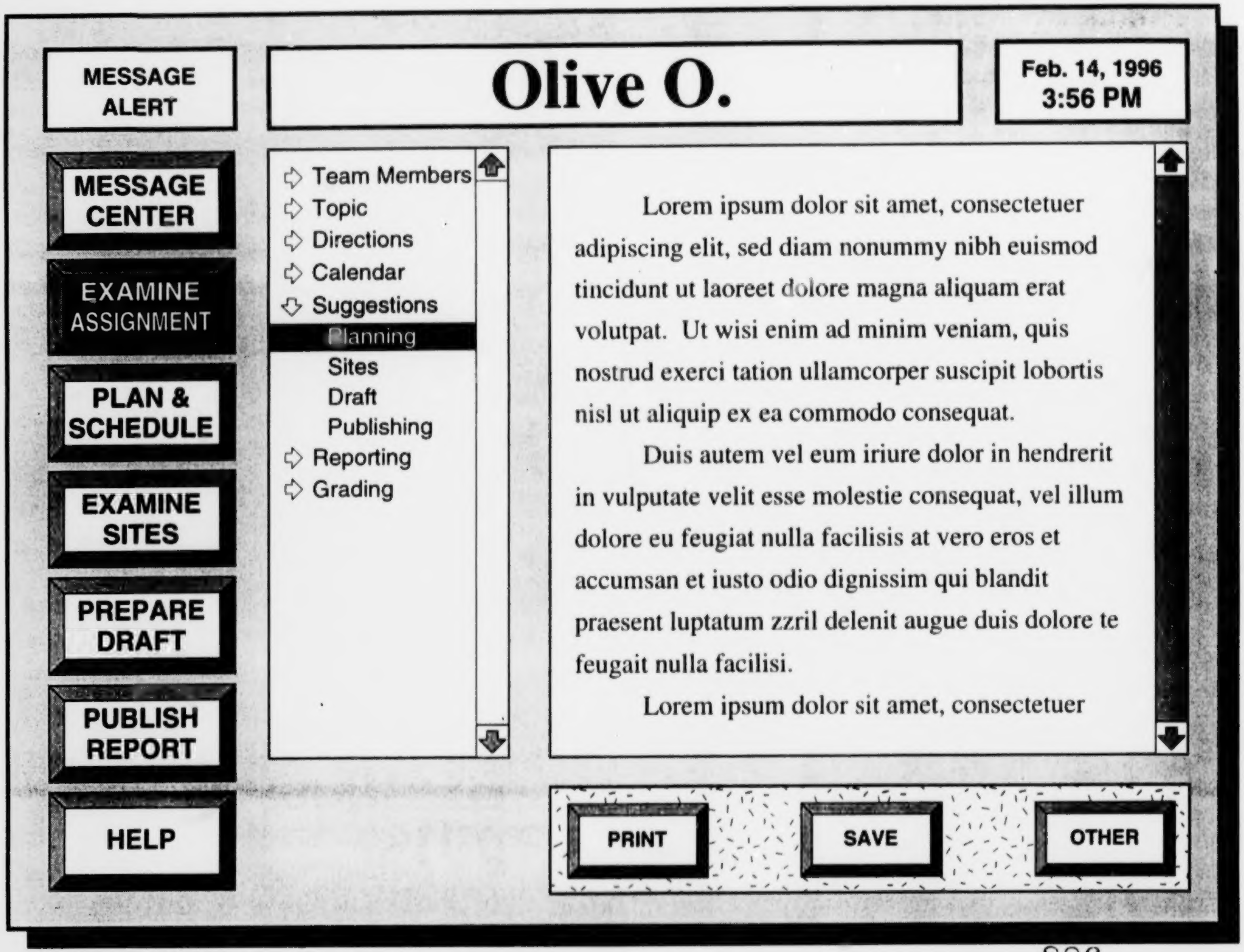

MESSAGE ALERT
Student's Name
DATE TIME
MESSAGE CENTER
EXAMINE ASSIGNMENT
PLAN & SCHEDULE
EXAMINE SITES
PREPARE DRAFT
PUBLISH REPORT
HELP
OPTIONS AREA
INFORMATION AREA
CONTROL PANEL
883
884

Figure 6.

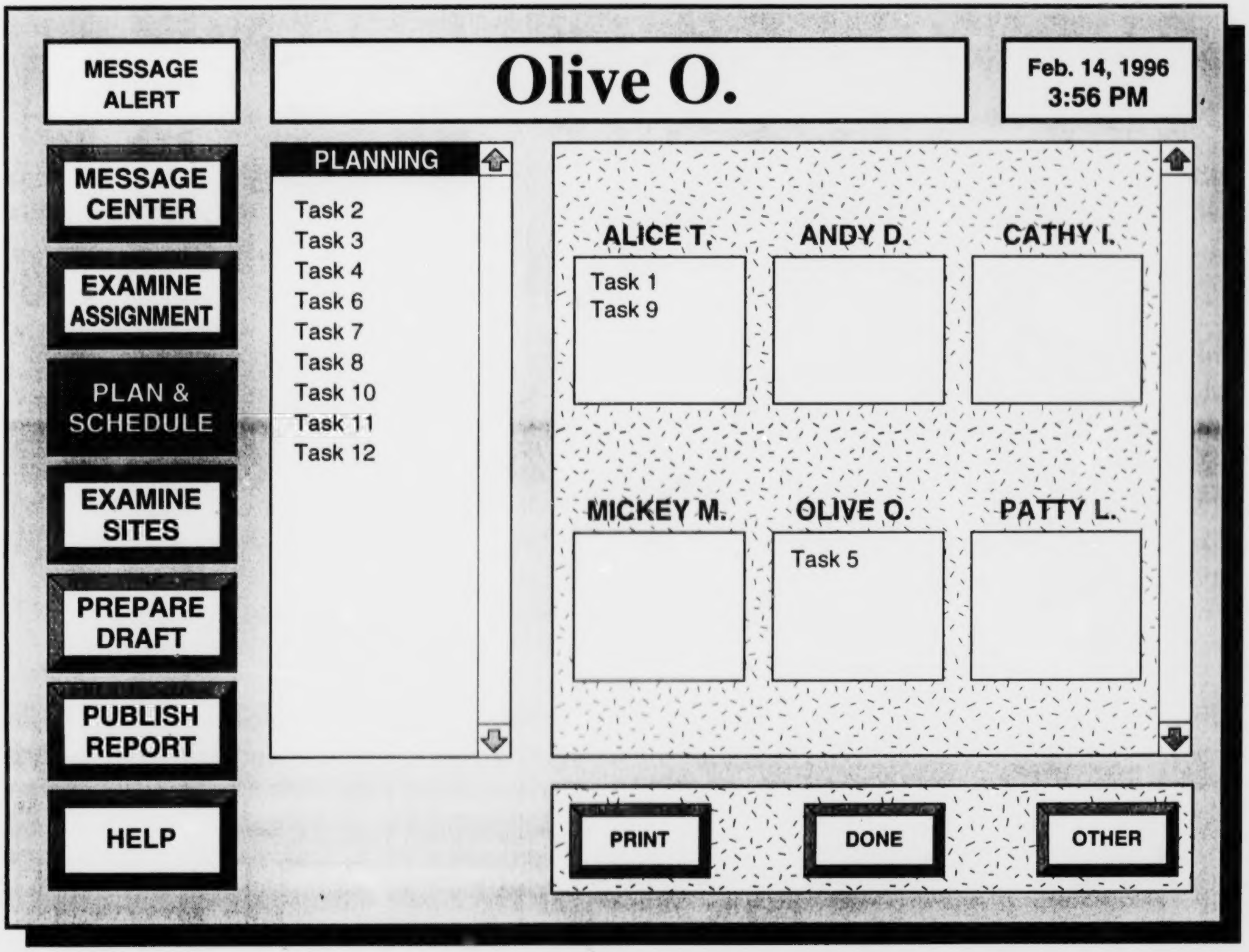

MESSAGE ALERT
Olive O.
Feb. 14, 1996
3:56 PM
MESSAGE CENTER
EXAMINE ASSIGNMENT
PLAN & SCHEDULE
EXAMINE SITES
PREPARE DRAFT
PUBLISH REPORT
HELP
Team Members
Topic
Directions
Calendar
Suggestions
Planning
Sites
Draft
Publishing
Reporting
Grading
PRINT
SAVE
OTHER
885
886

Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi.

Lorem ipsum dolor sit amet, consectetuer

Figure 7.


MESSAGE ALERT
MESSAGE CENTER
EXAMINE ASSIGNMENT
PLAN & SCHEDULE
EXAMINE SITES
PREPARE DRAFT
PUBLISH REPORT
HELP
PRINT
DONE
OTHER

Olive O.

Feb. 14, 1996
3:56 PM

PLANNING
Task 2
Task 3
Task 4
Task 6
Task 7
Task 8
Task 10
Task 11
Task 12

ALICE T.
Task 1
Task 9

ANDY D.

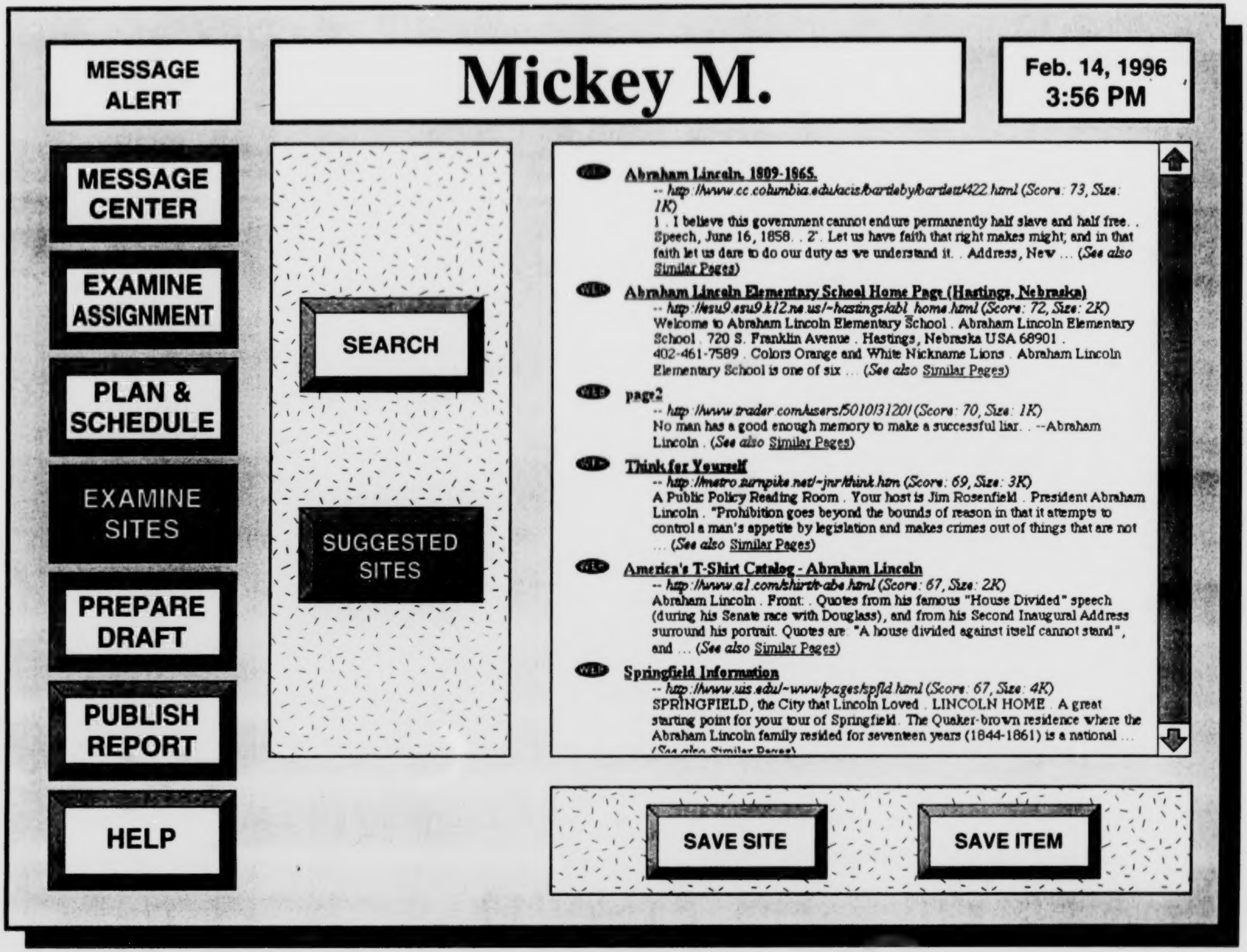
CATHY I.

MICKEY M.

OLIVE O.
Task 5

PATTY L.

Figure 8.



Mickey M.

Feb. 14, 1996
3:56 PM

Abraham Lincoln, 1809-1865.
-- *http://www.cc.columbia.edu/acis/bartleby/bartlett/422.html (Score: 73, Size: 1K)*
1 . I believe this government cannot endure permanently half slave and half free. . Speech, June 16, 1858. . 2'. Let us have faith that right makes might; and in that faith let us dare to do our duty as we understand it. . Address, New ... (*See also* Similar Pages)

Abraham Lincoln Elementary School Home Page (Hastings, Nebraska)
-- *http://esu9.esu9.k12.ne.us/~hastings/abl_home.html (Score: 72, Size: 2K)*
Welcome to Abraham Lincoln Elementary School . Abraham Lincoln Elementary School . 720 S. Franklin Avenue . Hastings, Nebraska USA 68901 . 402-461-7589 . Colors Orange and White Nickname Lions . Abraham Lincoln Elementary School is one of six ... (*See also* Similar Pages)

page2
-- *http://www.trader.com/users/5010/3120/ (Score: 70, Size: 1K)*
No man has a good enough memory to make a successful liar. . --Abraham Lincoln . (*See also* Similar Pages)

Think for Yourself
-- *http://metro.turnpike.net/~jnr/think.htm (Score: 69, Size: 3K)*
A Public Policy Reading Room . Your host is Jim Rosenfield . President Abraham Lincoln . "Prohibition goes beyond the bounds of reason in that it attempts to control a man's appetite by legislation and makes crimes out of things that are not ... (*See also* Similar Pages)

America's T-Shirt Catalog - Abraham Lincoln
-- *http://www.a1.com/shirt/t-abe.html (Score: 67, Size: 2K)*
Abraham Lincoln . Front: . Quotes from his famous "House Divided" speech (during his Senate race with Douglass), and from his Second Inaugural Address surround his portrait. Quotes are: "A house divided against itself cannot stand", and ... (*See also* Similar Pages)

Springfield Information
-- *http://www.uis.edu/~www/pages/spfld.html (Score: 67, Size: 4K)*
SPRINGFIELD, the City that Lincoln Loved . LINCOLN HOME . A great starting point for your tour of Springfield. The Quaker-brown residence where the Abraham Lincoln family resided for seventeen years (1844-1861) is a national ...
(*See also* Similar Pages)

Figure 9.

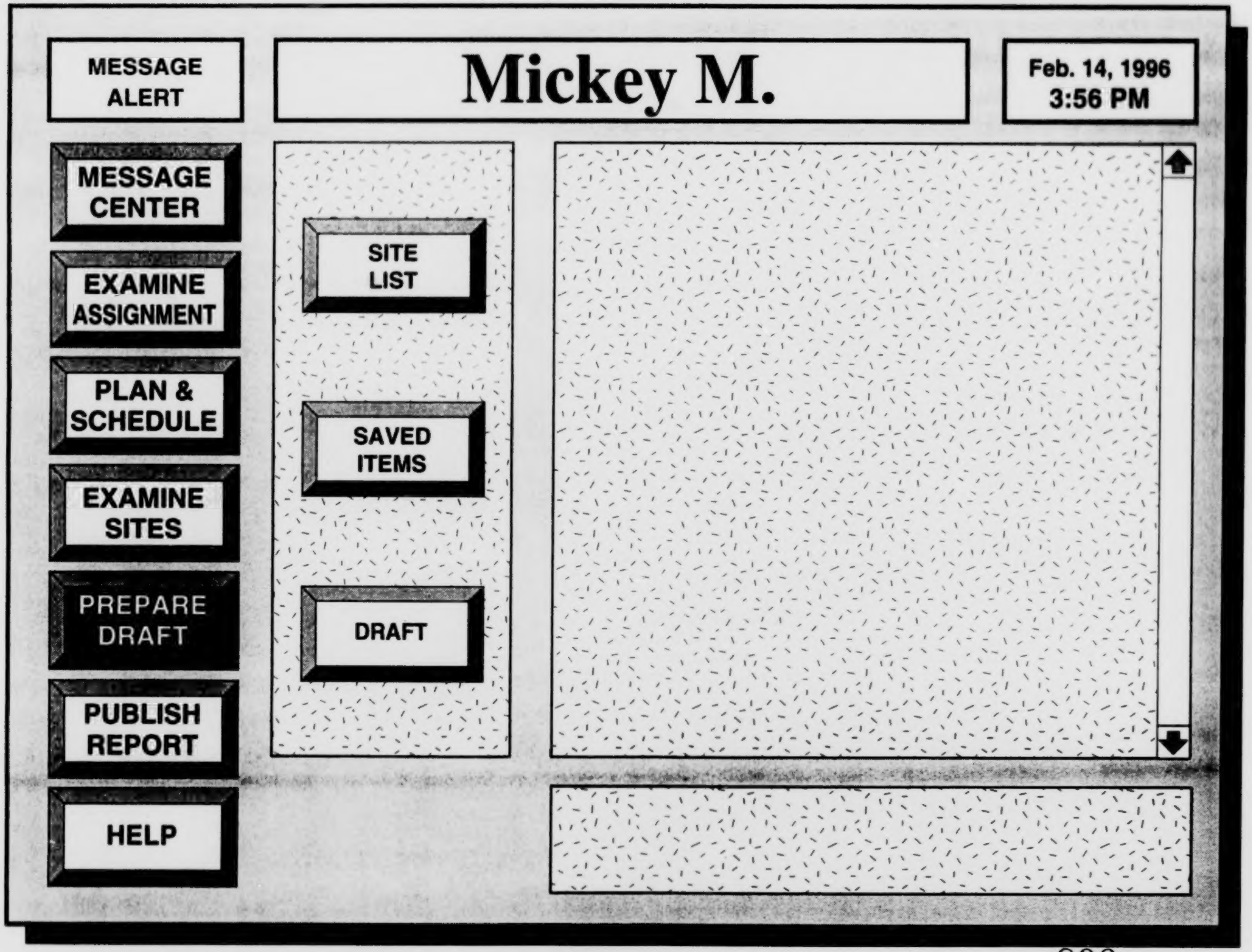

MESSAGE ALERT
Mickey M.
Feb. 14, 1996
3:56 PM
MESSAGE CENTER
EXAMINE ASSIGNMENT
PLAN & SCHEDULE
EXAMINE SITES
PREPARE DRAFT
PUBLISH REPORT
HELP
SITE LIST
SAVED ITEMS
DRAFT

Figure 10.

APPENDIX D

Figure 1. TV Viewing System

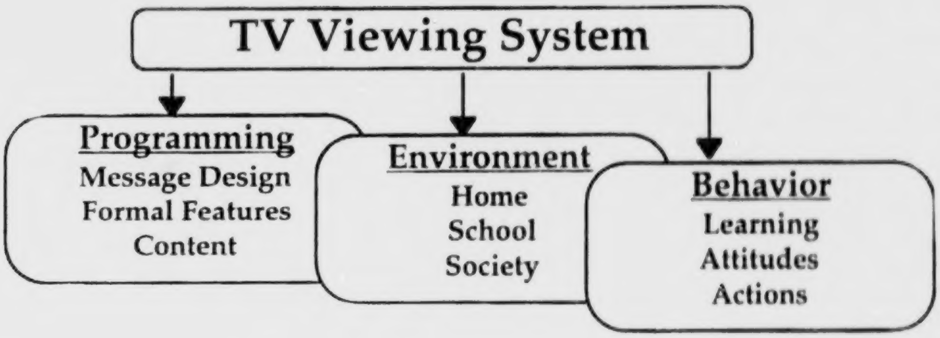
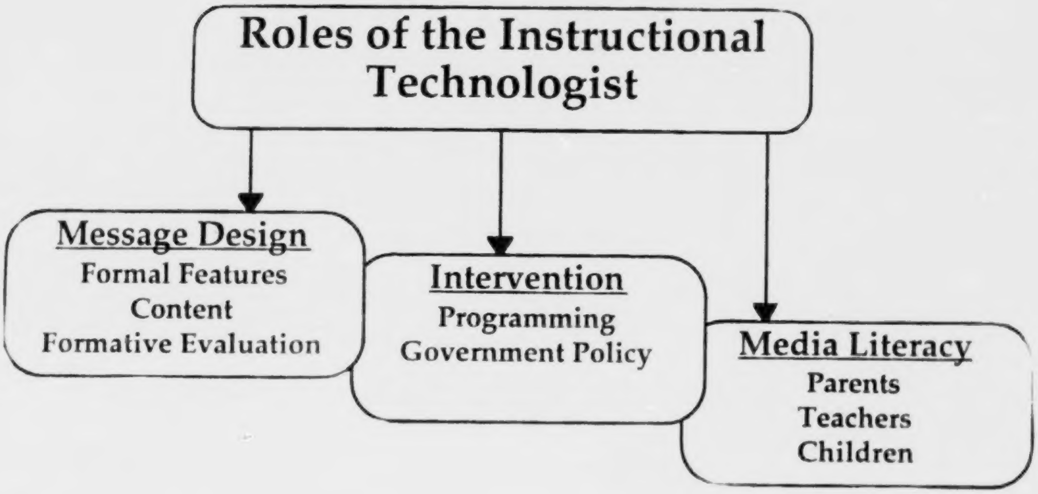

TV Viewing System
Programming
Message Design
Formal Features
Content
Environment
Home
School
Society
Behavior
Learning
Attitudes
Actions

Figure 2. Roles of the Instructional Technologist


Roles of the Instructional Technologist
Message Design
Formal Features
Content
Formative Evaluation
Intervention
Programming
Government Policy
Media Literacy
Parents
Teachers
Children

APPENDIX E

Figure 3. A Conceptual Framework for Message Design

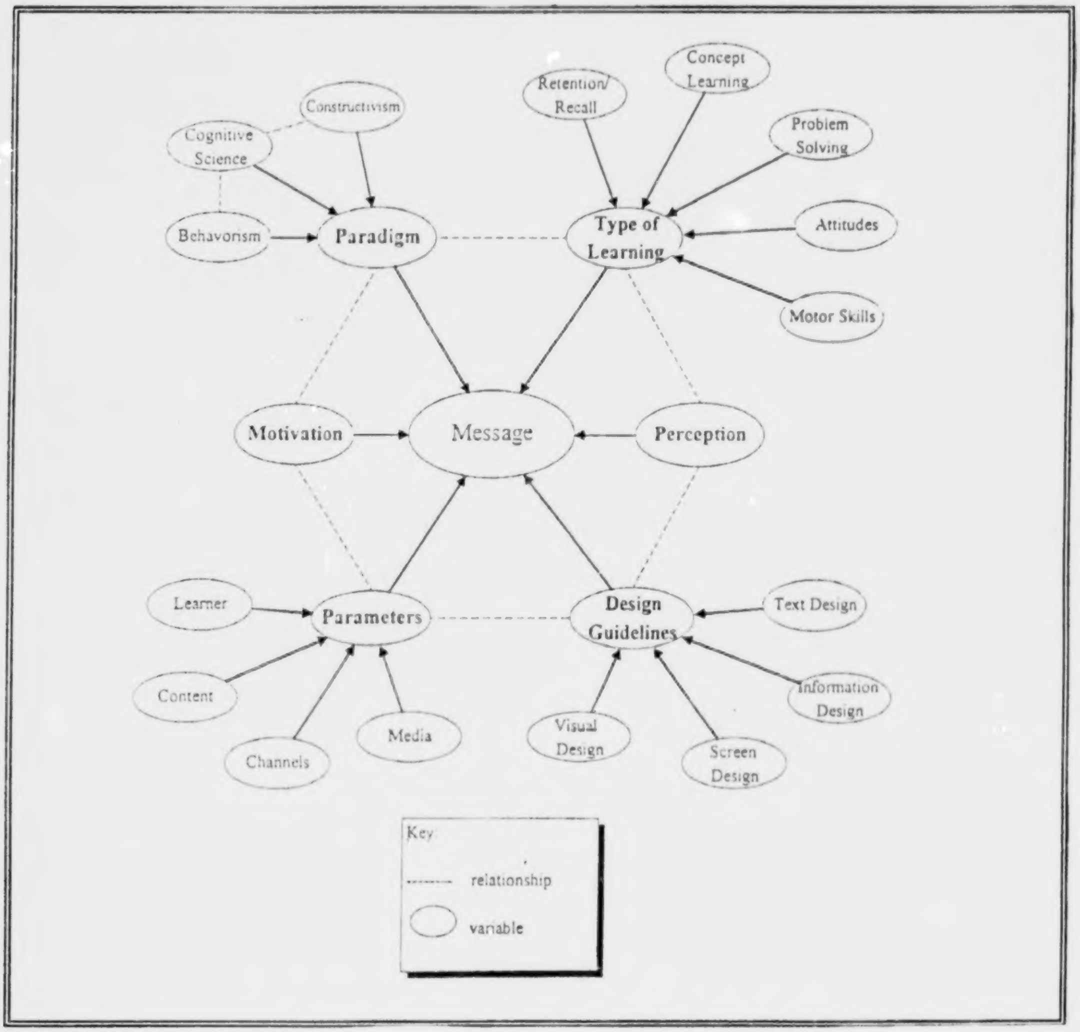
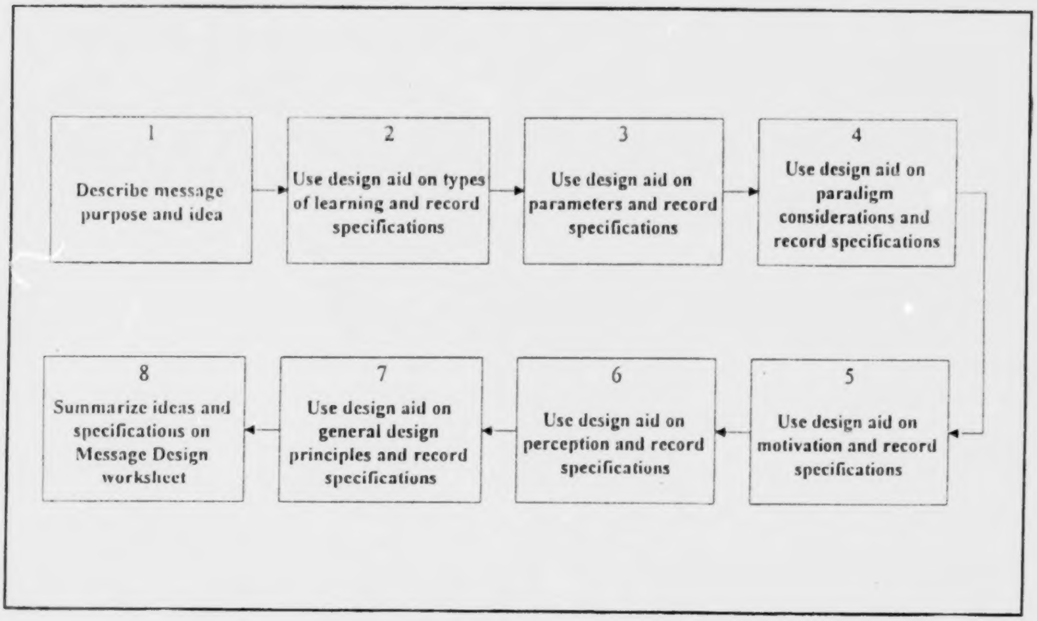

Constructivism
Cognitive Science
Behaviorism
Paradigm
Retention/ Recall
Concept Learning
Problem Solving
Attitudes
Motor Skills
Type of Learning
Motivation
Message
Perception
Learner
Content
Channels
Media
Parameters
Design Guidelines
Text Design
Information Design
Visual Design
Screen Design
Key
relationship
variable

Figure 4. A Flowchart of the Theory-Based Procedure


1
Describe message purpose and idea
2
Use design aid on types of learning and record specifications
3
Use design aid on parameters and record specifications
4
Use design aid on paradigm considerations and record specifications
5
Use design aid on motivation and record specifications
6
Use design aid on perception and record specifications
7
Use design aid on general design principles and record specifications
8
Summarize ideas and specifications on Message Design worksheet

APPENDIX F

The Effects of Varied Visual Manipulation Strategies within Computer-Based Instruction on Factual, Conceptual and Problem Solving Learning

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ABSTRACT

This study examined how the use of generative and non-generative visual manipulation strategies in computer-based instruction and level of prior knowledge influenced achievement on six posttest measures representing different levels of learning objectives. One-hundred-eighty-four undergraduate volunteers were administered a pretest on human physiology and categorized into high, medium and low prior knowledge groups. Subjects were randomly assigned to four treatments (visual summary with manipulation, learner manipulation, computer manipulation, and a control) based on their prior knowledge classification. After completion of the instruction, students completed a criterion-referenced test.

Analysis of variance revealed a significant effect for prior knowledge. No main effect was found for manipulation and a lack of interactive effect was found between prior knowledge and manipulation. Further analyses were conducted using pairwise comparisons to detect any potential treatment effects. Significant differences were found for the control treatment over learner manipulation of visuals in examining the pairwise comparisons. Similarly, significant differences were also found for the control treatment over computer manipulation of visuals. The presentation of static visual and textual information prior to manipulation of visuals indicates a potential variable to enhance learning over computer manipulation of visuals, while the control also seems to improve learning over computer-controlled manipulation. Exploratory analysis revealed results similar to the overall analyses. In addition, trends among mean scores supported the overall results and showed the control as exhibiting the highest mean scores on most measures for both high and low prior knowledge learners.

This study supports previous research that prior knowledge is a primary factor in learning. Those with high prior knowledge out-performed students with low prior knowledge on all measures. This research also suggests that the manipulation of visuals onto a visual framework may make the recall of factual and conceptual information more difficult. Presenting static visual and textual information prior to manipulation of visuals may potentially enhance learning on tasks requiring the learner to reconstruct a visual representation of concepts. However it is speculated that additional training with manipulation strategies should be presented to students. Further research with manipulation of visuals may help to determine the most appropriate methods for assisting learners in acquiring information in computer-based instruction.

INTRODUCTION

The necessity of the student's active role in the learning process has been well established by the cognitive movement in education. Designing instruction in a way that facilitates learners' meaningful interaction with and processing of information is a continuing challenge for instructional designers. Wittrock's (1974a; 1974b; 1990) generative learning theory presents a model for directing learner's cognitive processes to establish links to memory through the active construction of relationships and meaning. Activities such as the manipulation and organization of instructional elements by the learner can initiate the encoding process and have been shown to increase achievement in several contexts (Wittrock & Carter, 1975; Linden & Wittrock, 1981; Dee-Lucas & DiVesta, 1980). However, the generative manipulation and organization of visual elements in computer-based instruction is a fairly unexplored area of empirical investigation.

Through generative interaction, the learner constructs relationships among instructional elements or between the elements and his or her prior knowledge. Grabowski (1995, in press) distinguishes these two types of generative processing as organizational (constructing relationships among the parts) and integrational (constructing relationships among the instruction and prior knowledge). Generative activities involving visual elements have generally included student construction of pictures, drawings and mental images and have facilitated factual retention of definitions and enhanced reading comprehension (Linden & Wittrock, 1981; Bull and Wittrock, 1973). By creating visual representations, learners generate relationships between parts of the text to one another or between the text and their prior knowledge.

In addition to creating visual illustrations or drawings, the manipulation and organization of existing visual elements may also induce generative processing. Manipulation of concrete visual elements or manipulative materials have been widely used as instructional tools in the mathematics and science domains (Gabel & Sherwood, 1980;

Goodstein & Howe, 1978). Manipulative objects are used to encourage increased understanding through the transformation of concrete concepts to semi-concrete representations and finally, to the internalization of concepts through abstract thought (Berlin & White, 1986) . However, certain types of manipulative objects may be better in facilitating achievement than others (Sayeki, Ueno & Nagasaka, 1991). Manipulation of visual objects on the computer screen has traditionally been defined as animated or dynamic visuals-- those which move under the control of a computer or video delivery system. Park and Hopkins (1992) specify dynamic visual displays as any type of graphical movement during instruction. Their review of studies in this area indicate mixed results regarding the instructional effectiveness of dynamic visual displays. Milheim (1993) elaborates on the disadvantages of animated visual displays by highlighting the minimal interaction with the learner this type of presentation affords.

In contrast to computer-controlled dynamic visual displays, current development tools allow for the learner to interact with graphics. The computer interface described as the "direct manipulation interface," allows the learner to be directly engaged with visual objects on the screen, rather than indirect interaction through programming (Hutchins, Hollan & Norman, 1986). The movement and placement of visuals on the computer screen into a visual organization may induce generative processing. However, control of the manipulation, either by the learner or by the computer, may further account for the instructional effectiveness of this strategy.

Alesandrini (1984) promotes manipulation of visual elements as a potential instructional strategy, indicating that what seems to be important is the act of manipulation itself. Scheiderman (1992) contends that physical, spatial or visual representations of information appear to be easier to retain and manipulate than textual or numeric representations. Hennessey and O'Shea (1993) associate manipulation of computer representations with concrete objects in stating that while the instructional advantages to manipulating concrete objects has been well established, similar advantages of manipulating on-screen representations have not been well researched. Through the active manipulation of computer objects into a visual organization, the learner may consciously construct associations between the visual elements. This type of activity has the potential to provoke generative processing.

PROBLEM STATEMENT

Manipulation of visuals in computer-based instruction may assist the learner in creating necessary and appropriate associations among presented instructional stimuli. However, control of the act of manipulation--by the computer or the learner-- may impact the level of cognitive processing which occurs. Additionally, the learner's level of prior knowledge may impact what is learned. Finally, the learner's prior knowledge level may also influence his or her ability to capitalize on manipulation as a generative learning strategy.

Accordingly, the following questions were addressed in this study. Will the manipulation of visuals allow the learner to construct meaningful relationships among the presented instructional components? Does the active, overt, physical manipulation of on-screen visual elements by the learner induce generative processing? Does level of prior knowledge impact learning? Finally, is the manipulation and reorganization of visuals, as a generative learning strategy, appropriate for learners with certain levels of prior knowledge (high, medium or low) in recalling specific facts and concepts? This study examined the relationship between three different strategies for manipulating visuals --two generative and one non-generative type of manipulation, learners' prior knowledge and achievement on six measures demonstrating different levels of learning objectives.

METHOD

Subjects and Lesson Content

This study involved 184 subjects recruited from three undergraduate statistics courses at a large, eastern state university. The participants were administered a paper and pencil 36-item pretest and were categorized into high, medium and low prior knowledge groups. Stratified randomization was then used to randomly assign groups to conditions. The instructional materials used in this study were adapted from paper-based text materials developed by Dywer and Lamberski (1977) on the physiology and function of the human heart. The lessons included factual, conceptual and problem solving information and was re-created in computer-based instruction format using Authorware Professional.

Treatment Materials

Four computer-based treatments were developed for this study which contained identical instructional content while varying the type and presence of manipulation.

Visual Summary with Manipulation. Subjects in the visual summary with manipulation (VS-M) group viewed graphics with specific parts of the heart highlighted and corresponding textual information. The subjects were required to click *continue* to proceed through the majority of computer screens which contained static visual and text information. At five points in the instruction, the learner was presented with smaller graphical representations of four parts of the heart reviewed in that section on the left side of the screen and a target box on the right side (See Figure 1). Using these parts, the learner then constructed their own visual summary of the information by clicking, dragging and organizing the parts into the box based on what they had learned. Correct placement of these parts was not judged and learner needed only to place all parts in the box in order to continue (See Figure 2). The organization of visuals depicted a generative representation or visual summary of the learner's understanding of the previous information.

Learner-Manipulation. Subjects in the learner-manipulation (L-M) group were required to click and drag a visual graphic of a part of the heart from the left side of the screen onto a visual frame of the whole heart containing an outline of the primary parts (See Figure 3). No text was presented prior to the movement, forcing the learner to first discover the correct position on the heart. If the part was not placed correctly, it automatically returned to its original position in the left hand corner of the screen, providing animated negative visual feedback. The subject was required to place the visual again and was permitted three attempts after which the part would animate to its correct position. After successful placement of the part, textual information describing the part, its location, function and/or relationship to other parts of the heart appeared next to the visual (Figure 4). This activity represented a generative approach where subjects would mentally construct associations among the presented visuals through manipulation.

Computer-manipulation. In the computer-manipulation (C-M) treatment, the learner was presented with a part of the heart on the left side of the screen and an identical visual frame of the whole heart as presented in the learner-manipulated treatment as shown in Figure 3. However, in the C-M treatment, the learner did not click and drag the part, but instead clicked *continue* which caused the part to animate to the correct location. At that point, the textual information describing the part, its location, function and/or relationship to other parts of the heart appeared. This activity represented a non-generative form of manipulation of visuals.

Control. The control group presented the lesson content via text and graphics in a page-turning format with no learner manipulation of visuals. Subjects viewed graphics with specific parts of the heart highlighted and their corresponding textual information (Figure 5). The only action required by the learner was to click *continue* to proceed.

Dependent Measures and Reliability

The posttests used in this study consisted of paper and pencil tests encompassing a total of 100 questions. Generally, the five tests were designed to measure the ability of the student to identify individual parts of the heart using visual cues, retain facts, terms and definitions related to the heart as well as utilize information for problem solving. Each test consisted of twenty multiple-choice questions.

Specifically, the identification test evaluated retention of factual information and required students to identify the names of parts on drawings of the heart. The terminology test was designed to measure knowledge of facts, terms and definitions. The comprehension test measured the ability of the student to use the information to explain another phenomenon occurring simultaneously. The problem solving test assessed the student's ability to apply their understanding of the information in reasoning about alternative situations. The identification, terminology, comprehension and drawing tests required the learner to view visual or draw representations of the heart and select the correct location or position of parts while the problem solving test was presented through comprehension of textual information. The total written test highlighted the students overall performance in combining all measures except the drawing test reflecting a composite score.

Internal consistency measures were computed for each of the tests using Cronbach alpha reliability coefficient which is equivalent to the KR-20 (Kuder-Richardson-20). The following Cronbach alpha coefficients were found: .79 Identification, .75 terminology, .74 comprehension, .70 problem solving, .79 total test, and .83 Drawing.

Procedures

The study was introduced to students during regular sessions of their respective statistics course. To divide the groups into high, medium and low prior knowledge levels, a technique which has been used in at least one previous study involving the same instructional materials was used (Akanbi, 1986). Subjects were classified as high, medium or low prior knowledge based on whether their pretest score was more than one half a standard deviation above the mean, or between one half standard deviation above and below the mean or more than one half a standard deviation below the mean. The pretest results were used as an scheme to randomize subjects from all three classes into high, medium and low prior knowledge groups.

Treatments were conducted in one of the University computer labs. Upon completion of the instruction, posttests were immediately administered in a nearby classroom in the following succession: drawing, identification, terminology, comprehension and problem-solving tests. The treatments were presented via computer while the pretest and final testing were delivered in traditional, paper and pencil format.

Research Design and Data Analysis

This study employed a post-test only control group design and stratified random sampling. Stratified sampling was used in order to examine differences that might exist between subgroups of the subject population. The basis for stratification in this study was level of prior knowledge (high, medium and low) which was assessed by the pretest on human physiology.

A two-factor analysis of variance (ANOVA) was used to test for interaction effects between the factors (prior knowledge and type of manipulation) and for significant main effects among the four groups for each criterion measure: drawing, terminology, identification, comprehension, problem solving and total written test which included a composite score of all tests except drawing. In all cases, .05 alpha level was selected to determine significance.

RESULTS

Descriptive results for achievement showing the mean scores and standard deviations for the four treatments for each immediate posttest are shown in Table 1. Differences in performance levels of the four treatment groups showed little variance in mean scores across all prior knowledge levels on each of the posttests. The control group showed the strongest performance on all criteria except problem-solving and drawing where visual summary with manipulation (VS-M) recorded the highest mean scores, although not a dramatic increase. Students in the computer manipulation group (CM) demonstrated the lowest mean scores on all measures except terminology and problem solving.

Table 2 shows mean scores and standard deviations for three levels of prior knowledge for each criterion measure across all treatment groups. The high prior knowledge group scored consistently higher on each posttest measure than the medium prior knowledge group, followed by low prior knowledge.

An analysis of variance was run on each of the dependent measures as shown in Table 3. ANOVA revealed a significant main effect on all measures for prior knowledge while the main effects for the factor of manipulation were not significant across all measures. Results also revealed no interactive effect between the factors of prior knowledge and the manipulation conditions on all measures.

Students with high prior knowledge scored significantly better than those with low prior knowledge on all measures. The performance of those students with medium level of prior knowledge differed significantly from those with low on the terminology, comprehension, problem solving and total written tests.

On the problem solving measure, all three levels of prior knowledge differed significantly from one another with the high level group ($\underline{M}$=12.8) performing better than the medium group (M=10.64) and better than the low group (M=9.31). Similarly, for the total written test which subsumes all tests except the drawing measure, the results indicated significant differences between the high, medium and low prior knowledge groups with means of 17.14, 15.92, and 14.65 respectively.

Although the F-tests for each measure examining treatment effects for manipulation were not significant overall, additional analyses examining pairwise comparisons were conducted in order to further investigate the data. In the subsequent discussion, these results merely suggest an effect for the treatments which may have been masked by the overall effect of both treatment and prior knowledge.

While the overall ANOVA was not significant on the identification measure, differences were noted among the pairwise comparisons of learner manipulation and control group. There were notable differences indicated between the control group (M=16.46) which scored higher than the learner manipulation (M=15.26) and computer manipulation group (M=14.95). Further analysis on the terminology test indicated that the control group (M=13.84) outperformed the learner manipulation group (M=12.34). On the comprehension test, the control group (M=14.28) outperformed both the visual summary with manipulation (M=12.83) and computer manipulation groups (M=12.66). In addition, for the total written measure, the control group's (M=55.80) performance exceeded the learner manipulation (M=51.34) and computer manipulation groups (M=50.78).

In contrast to the other results, on the drawing test the visual summary with manipulation group (M=16.73) outperformed the computer manipulation group (M=14.85). However, similar to the other analyses, the control group scored higher than the computer manipulation group (M=14.85).

CONCLUSIONS

This study investigated the effects of visual manipulation strategies as well as the effects of three levels of prior knowledge on learner achievement on six types of learning objectives. The manipulation strategies represented two forms of generative manipulation and a computer-controlled or non-generative manipulation strategy in computer-based instruction. The results generally indicated that students who interacted with the control treatment performed better than those who interacted with the manipulation strategies for most measures as evidenced by higher mean scores. However, the differences between the groups were not statistically significant.

As expected, learners' level of prior knowledge was found to significantly influence their performance on all posttests. Students who were categorized as having high prior knowledge significantly outperformed students who were categorized as having low prior knowledge on all posttest measures. Additionally, no significant interaction effect was found between the factors of prior knowledge and manipulation.

The overall findings of this study suggest that the manipulation of visuals in computer-based instruction constitutes a novel, unconventional, demanding and possibly a distracting generative strategy for students. While generative learning theory provides a strong theoretical foundation for this strategy, the results clearly reflect the need for students' increased familiarity and practice with this type of instructional approach. In this regard, Hooper, Sales & Rysavy (1994) have suggested that students need to practice using generative learning strategies before they can use them effectively. Mayer (1984) elaborates on this position in regard to organizational tasks by maintaining that the building of internal connections between instructional stimuli and learners' knowledge may be enhanced by explicit training in the organization of items for meaningful learning tasks.

The need to train students to capitalize on generative strategies is even more pronounced when they interact with visual elements in a novel fashion as was required in this study. Traditional methods of instruction typically involve the simultaneous presentation of static visual and textual information. As a result, learners may be conditioned to this type of information presentation interacting with static displays of images. With increased exposure, students perhaps become more visually literate in acquiring information and constructing meaning from this static visual presentation of information. Consequently, learners may tend to rely upon these established and well-honed strategies for learning, rather than attempting to cognitively interact with unfamiliar methods of manipulating visual information.

The students in this study physically interacted with the visual elements, but may not have been cognitively engaged in constructing relationships among the visuals and textual information during the manipulation. Generative connections may have been formed among the visual parts and their spatial relationships, but not constructed between the visuals and the textual information. In all three manipulation treatments, the learner was presented with a screen of visual and textual information that was equivalent to the control condition, after the visual elements were manipulated. Instead of directing attention toward forming generative relationships among the instructional elements, the manipulation of the visuals may have delayed learners from focusing on or processing the static visual and textual information until after the visuals were placed in position at which time they reverted back to familiar strategies for learning the content.

In addition, the manipulation and reorganization of visual information may make the recall of specific facts and concepts more difficult for some learners. This point raises a concern for the necessity of learners' metacognitive awareness of generative strategies and their instructional purpose. Although a practice screen was presented to the student prior to the instruction in this study, the purpose of the screen was primarily for students to practice the mechanics of manipulating visuals in order to move through the lesson. Perhaps the subjects in this study needed a clearer understanding of the instructional purpose of the manipulation strategies, such as suggestions on how to process the information while manipulating the visual information.

Important conclusions from this study also involve the amount and order of presenting instructional information prior to the learner's engagement in a generative task involving the manipulation of visuals. Mayer and Anderson (1992) recommend presenting animated visuals and textual information contiguously in time and space. This study supports the notion that an adequate amount of visual and textual information may need to be presented in a traditional fashion prior to generative interaction with visual elements for particular learning objectives rather than presenting the visual information and then text.

The learners' level of prior knowledge greatly influenced performance on the posttests. Significant differences in performance were detected between distinct groups of students classified into high, medium and low prior knowledge levels on most measures. The influence of this factor was not unexpected based on previous studies of this effect (Chase & Simon, 1973; Chi, 1978; Chiesi, Spilich, & Voss, 1979; Spilich, Vesonder, Chiesi, & Voss, 1979; Voss, 1977). Their research has shown that the knowledge an individual brings to the learning situation is a primary factor influencing learning. This study clearly supports this research in that the learner's prior knowledge provided a basis for the assimilation and accommodation of new information into the learner's schema.

Additional results indicated that there were no significant interactions between prior knowledge and treatment on all measures. It was expected that those students with low prior knowledge would benefit from the generative manipulation strategy, while those with high prior knowledge would not require additional strategies for learning. Although at least one study has shown an interaction between prior knowledge and generative strategies (Peper & Mayer, 1986a), it was not apparent in this experiment. These results may be due to the fact that students may not have processed information based on the manipulative task, thereby rendering the strategy inefficient to impact the retention of information at any level of prior knowledge.

In examination of the mean scores, students with high and low prior knowledge benefited from the control condition. These results support other findings that perhaps generative strategies are not necessary for those with high prior knowledge and students with low prior knowledge may benefit from additional practice with these strategies. Trends among the mean scores also suggest manipulating visuals into a summary after viewing static visual and textual information may potentially be as effective as traditional forms of information presentation for learners with high and medium prior knowledge on higher level learning objectives.

Although many of the above findings are only speculative, further research is needed to support the use of manipulation as a generative learning strategy. This study has contributed information for the use of a novel strategy in computer-based instruction. The results indicate the manipulation of visuals holds promise for increasing the level of processing induced by the learner when interacting with visual information. However, only with future research can the appropriate and effective use of manipulation strategies be revealed. Future results should determine if metacognitive training is required, if the use of visual manipulation tasks more suited to the cognitive outcome can facilitate learning or if different types of manipulation strategies can facilitate achievement.

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Table 1

Descriptive Data for Treatments on Each Criterion Measure

	VS-M n=42	LM n=50	CM n=47	Control n=45
Identification				
M	15.97	15.26	14.91	16.46
SD	(2.83)	(3.21)	(3.18)	(2.56)
Terminology				
M	12.92	12.34	12.76	13.84
SD	(3.59)	(3.82)	(2.85)	(2.76)
Comprehension				
M	12.83	13.08	12.66	14.28
SD	(3.67)	(3.75)	(3.74)	(2.73)
Problem-Solving				
M	11.52	10.66	10.87	11.20
SD	(3.69)	(3.87)	(3.48)	(3.23)
Total Written				
M	53.26	51.34	50.78	55.80
SD	(11.87)	(12.86)	(11.30)	(9.14)
Drawing				
M	16.73	15.86	14.85	16.62
SD	(4.44)	(4.23)	(4.46)	(3.22)

Table 2

Descriptive Data for Prior Knowledge Level on Each Criterion Measure

	High n=70	Medium n=56	Low n=58
Identification			
M	16.44	15.48	14.79
SD	(2.92)	(2.82)	(3.14)
Terminology			
M	13.98	13.14	11.51
SD	(3.41)	(2.95)	(3.06)
Comprehension			
M	14.32	13.25	11.82
SD	(3.62)	(3.37)	(3.13)
Problem-Solving			
M	12.80	10.64	9.31
SD	(3.37)	(3.38)	(3.01)
Total Written			
M	57.55	52.16	47.44
SD	(11.71)	(10.32)	(9.87)
Drawing			
M	17.14	15.92	14.65
SD	(4.00)	(3.91)	(4.23)

Table 3

ANOVA Tables for All Measures

ANOVA Table for Identification

	df	Sums of Squares	Mean Sq.	F-Value	P-Value
Manipulation	3	66.577	22.192	2.549	.0575
Prior Knowledge	2	81.317	40.659	4.669	.0106*
Manip. * Prior Know.	6	28.11	4.685	.538	.7788
Residual	172	1497.684	8.707		

ANOVA Table for Terminology

	df	Sums of Squares	Mean Sq.	F-Value	P-Value
Manipulation	3	55.361	18.454	1.853	.1393
Prior Knowledge	2	194.974	97.487	9.791	<.0001***
Manip. * Prior Know.	6	53.462	8.910	.895	.4999
Residual	172	1712.495	9.956		

ANOVA Table for Comprehension

	df	Sums of Squares	Mean Sq.	F-Value	P-Value
Manipulation	3	71.649	23.883	2.080	.1046
Prior Knowledge	2	174.084	87.042	7.581	.0007**
Manip. * Prior Know.	6	54.418	9.070	.790	.5789
Residual	172	1974.710	11.481		

Table 3 continued

ANOVA Tables for All Measures

ANOVA Table for Problem Solving

	df	Sums of Squares	Mean Sq.	F-Value	P-Value
Manipulation	3	30.750	10.250	.958	.4139
Prior Knowledge	2	415.415	207.708	19.416	<.0001***
Manip. * Prior Know.	6	66.080	11.013	1.030	.4078
Residual	172	1840.011	10.698		

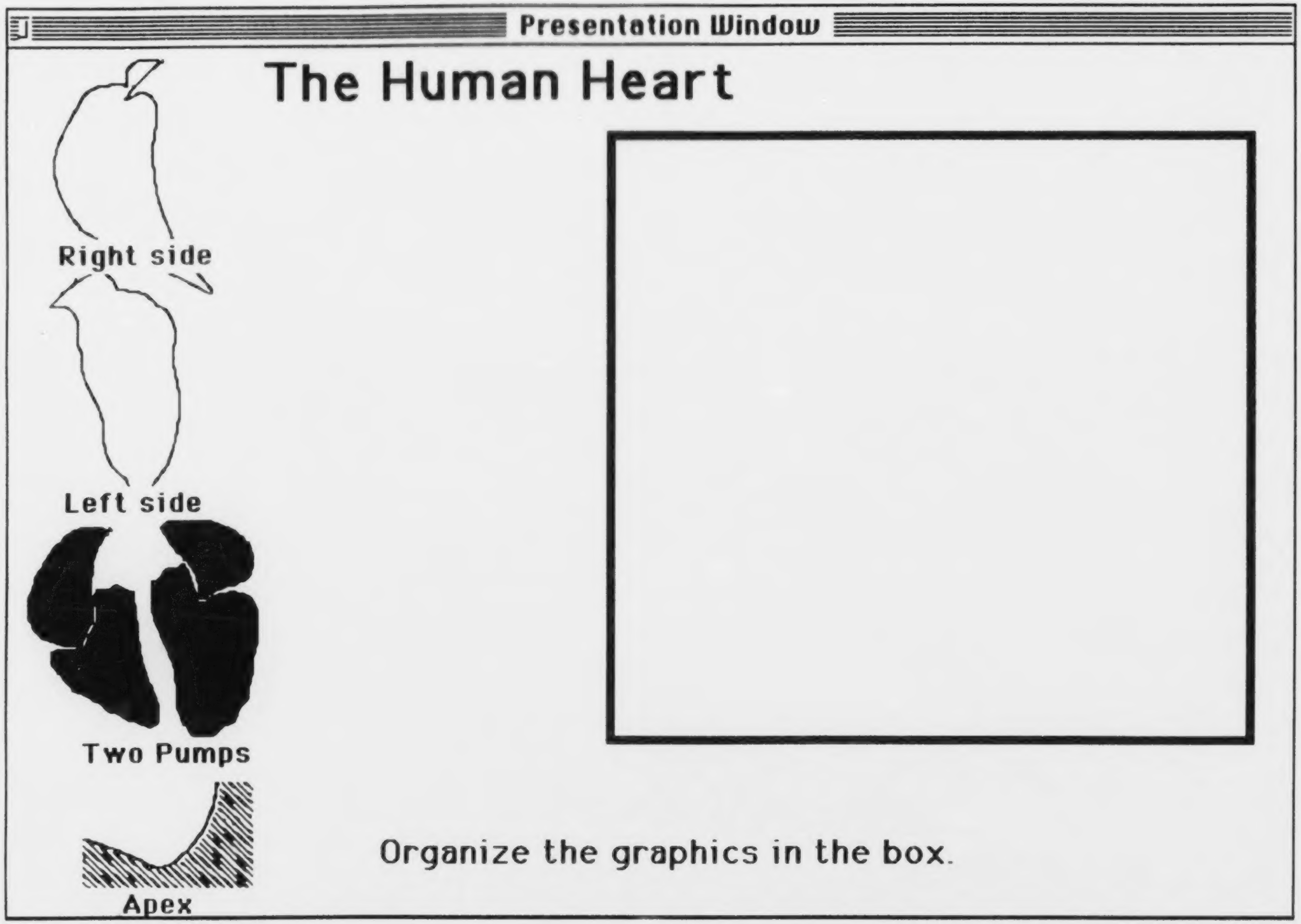
ANOVA Table for Total Written

	df	Sums of Squares	Mean Sq.	F-Value	P-Value
Manipulation	3	723.664	241.221	2.094	.1028
Prior Knowledge	2	3173.744	1586.872	13.776	<.0001***
Manip. * Prior Know.	6	419.145	69.858	.606	.7249
Residual	172	19812.306	115.188		

ANOVA Table for Drawing

	df	Sums of Squares	Mean Sq.	F-Value	P-Value
Manipulation	3	91.256	30.419	1.860	.1382
Prior Knowledge	2	197.900	98.950	6.051	.0029*
Manip. * Prior Know.	6	60.485	10.081	.616	.7169
Residual	172	2812.589	16.352		

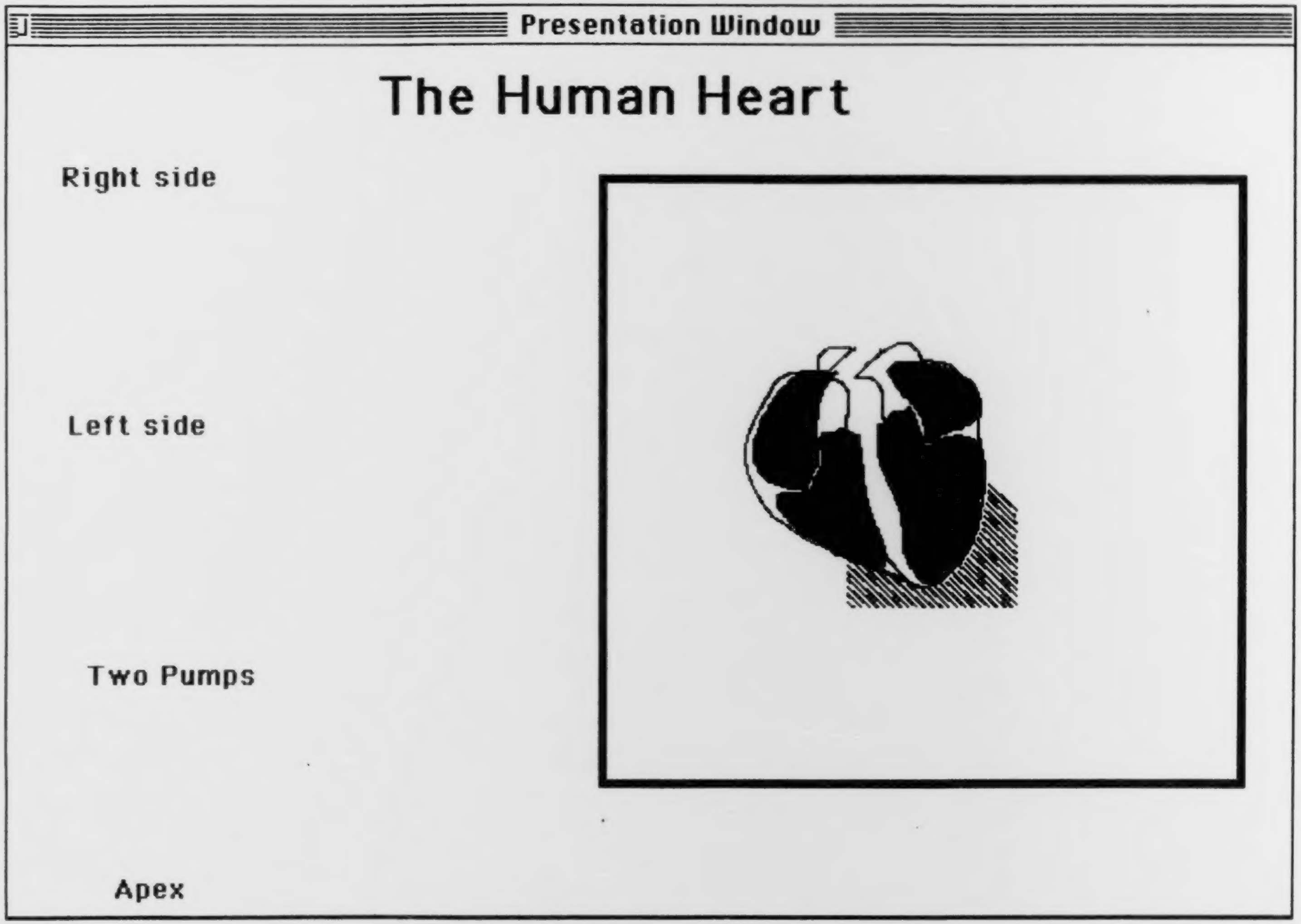
*p<.05
**p<.01
***p<.0001


Presentation Window
Right side
Left side
Two Pumps
Apex

The Human Heart

Organize the graphics in the box.

Figure 1. Visual Summary with Manipulation Treatment


Presentation Window

The Human Heart

Right side

Left side

Two Pumps

Apex

Figure 2. Completed Visual Summary

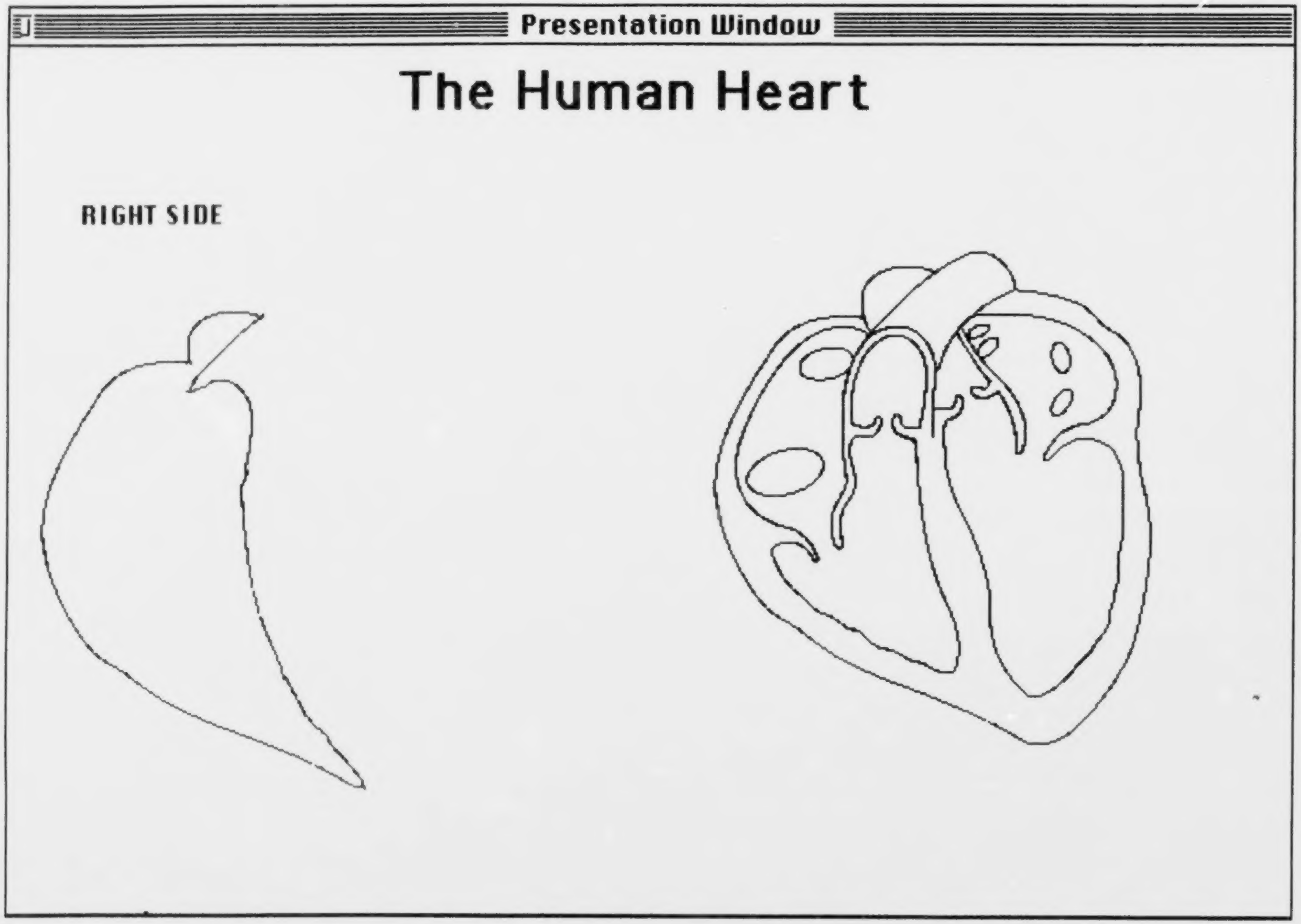
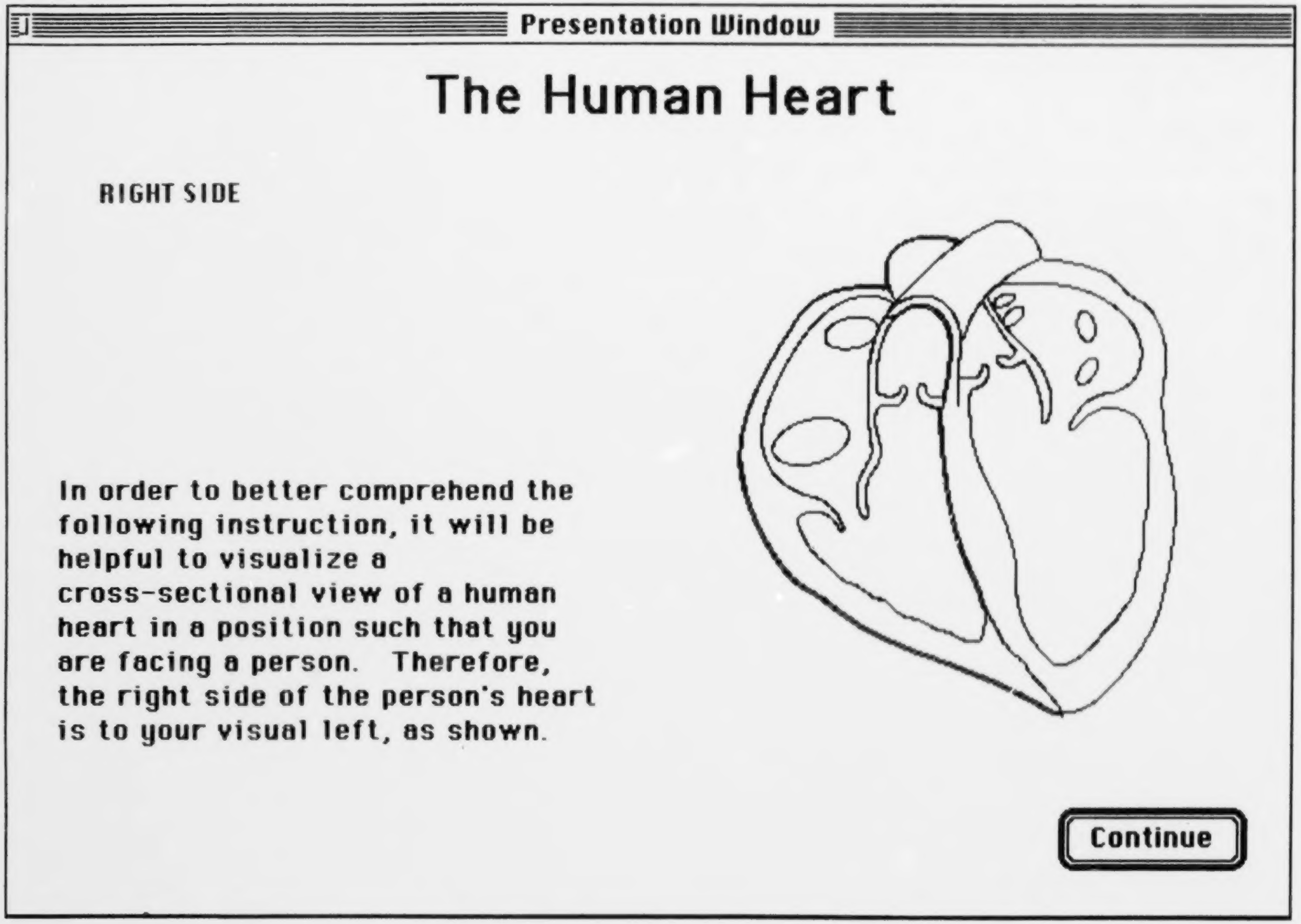

Presentation Window
The Human Heart
RIGHT SIDE

Figure 3. Learner Manipulation Treatment

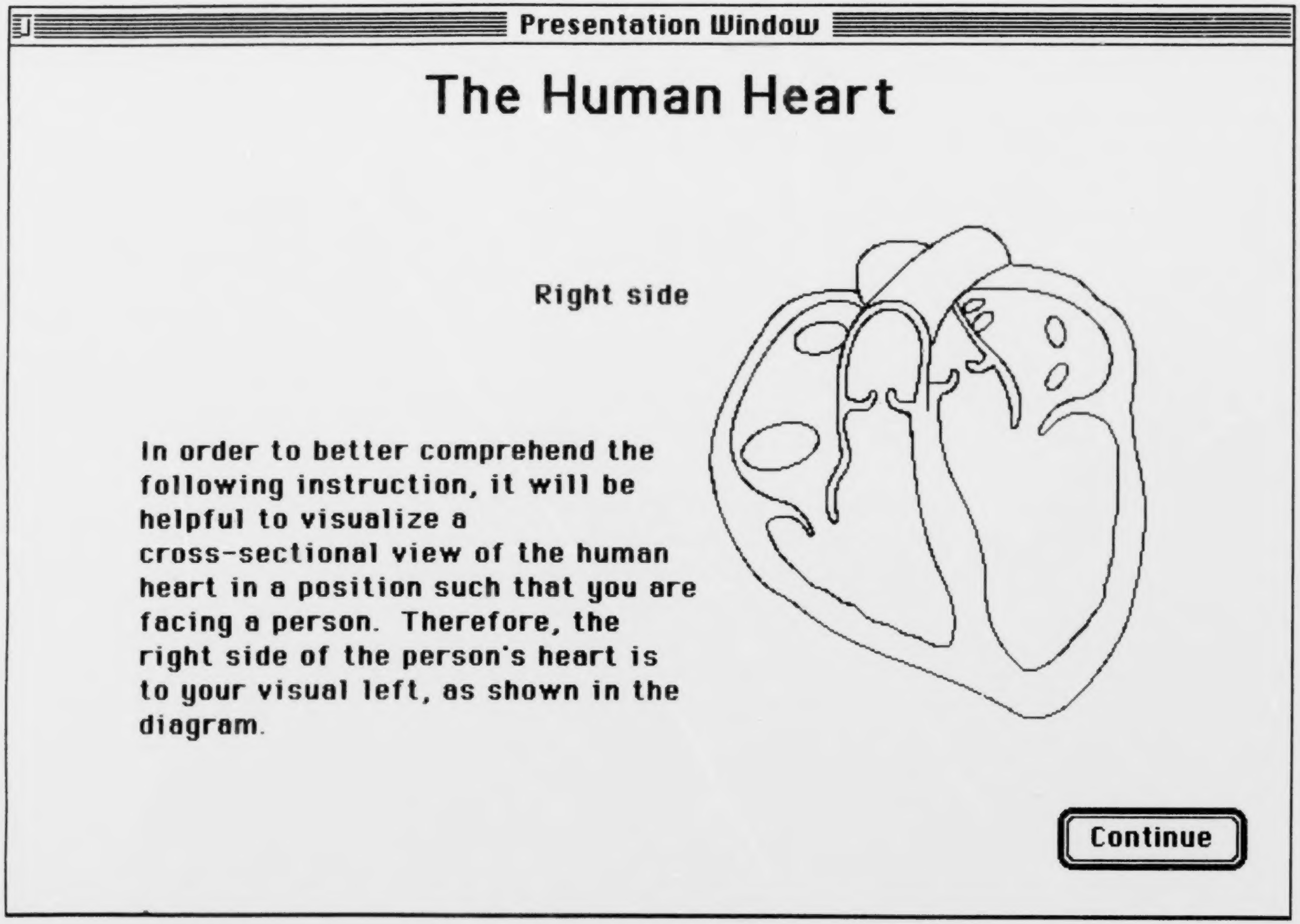


The Human Heart

RIGHT SIDE

In order to better comprehend the following instruction, it will be helpful to visualize a cross-sectional view of a human heart in a position such that you are facing a person. Therefore, the right side of the person's heart is to your visual left, as shown.

Figure 4. Completed Learner Manipulation


Presentation Window
Right side
Continue

The Human Heart

In order to better comprehend the following instruction, it will be helpful to visualize a cross-sectional view of the human heart in a position such that you are facing a person. Therefore, the right side of the person's heart is to your visual left, as shown in the diagram.

Figure 5. Control Treatment

Utilizing the Concerns-Based Adoption Model to Facilitate Systemic Change

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Utilizing the Concerns-Based Adoption Model to Facilitate Systemic Change

We have become a technologically based society. Every facet of our lives requires us to interact with technology in some form or manner. The economic structure of the United States has shifted from an industrial economy to a technology based economy. The tremendous growth and evolution of technology has created challenges for education. In our society, technology has moved from being a "nice to have" option to a necessity.

Education is being forced to keep up with the increasing demands placed on the workforce. There has been a call for systemic restructuring of our educational system, so that it can better meet these demands. These ever increasing demands place an added burden on schools, educators and instructional designers. Today's job market places a premium on people who are motivated, self-directed learners. Educators and instructional designers need to work together to equip students with the intellectual tools, self-beliefs, and self-regulatory processes which will enable them to meet the needs of employers by becoming self-directed learners (Bandura, 1993).

In restructuring education, technology will become a vital tool for helping students build self-regulatory skills, enhancing the productivity of the learning environment and the quality of the experience. Technology has been defined as the use of scientific knowledge to solve educational problems (Anglin, 1995). According to this definition, technology includes not only hardware but also the systemic and systematic processes associated with the management and solution of educational problems.

Technology

The most recognized symbols of technological advancement are the microcomputer and the Internet (Office of Technology Assessment, 1988; Ely, 1993). The microcomputer can be found in ninety-eight percent (98%) of elementary and secondary school environments across the United States (Quality Education Data, 1992) and microcomputers have become so deeply ingrained in mainstream society that a place in the subculture of schooling is assured (Maddux, Johnson, & Harlow, 1993). "If we anticipate a future when more students need more learning there is only one way to meet that need without diminishing the quality of students' learning experiences: we must change the way we deliver education" (Twigg, 1993, p. 11).

LeBaron and Bragg (1994), predict that by the year 2000 a window of opportunity will develop for instructional technology, when the natural process of attrition will become intense because of an aging teacher workforce. A new breed of teacher will be able to take the lead in education. Ways for infusing teacher preparation programs with effective use of instructional technologies need to be developed to help this new breed of teacher to better serve the needs of a technological based economy.

LeBaron and Bragg (1994) state that currently, preservice teachers are graduating from college with skills similar to those of thirty years ago. With few notable exceptions, instructional technologies are typically presented to preservice teachers in a manner which fails to model the seamless integration of technology into the classroom (Lampert & Ball, 1990; LeBaron & Bragg, 1994). For instructional technology to truly become integrated within the school classroom, appropriate integration of these technologies must be defined, modeled, and mentored for the preservice teacher.

Systemic Change

Those promoting systemic change propose three alternatives for bringing about change: (a) discard the current system and start over, (b) restructure the current system, and (c) build a parallel system. Robert Reiser and David Salisbury (1995) express the view that efforts to change the current school structure through a restructuring effort involving preservice teacher education are ineffective. They base this conclusion largely on the view that the "tradition of teaching" inhibits change within the educational structure. The "tradition of teaching" is seen to have a powerful hold on teachers and makes it difficult for them to abandon the practices that have become an integral part of the public school culture. However, Reiser and Salisbury (1995) assert the hope that by modeling systems theory for pre-service teachers, they will see the value of incorporating technology into their teaching and will be able to facilitate systemic change in education.

Systemic change can be facilitated by promoting a mindset that includes strategies or methods that are used to understand education (Jenlink, Reigeluth, Carr, & Nelson, 1996). Systemic change "recognizes the interrelationships and interdependencies among the parts of the educational system, with a consequence that desired changes in one part of the system are accompanied by changes in other parts that are necessary to support those desired changes" (Jenlink et al., 1996, p. 22). The premise presented in this paper is that pre-service teacher education, by following these guidelines, can become an active participant in bringing about systemic change within the individual classroom, and also within the entire school system.

Research regarding the diffusion of instructional technologies into the public school system indicates that the process has been laboriously slow and in many cases ineffective (Cuban, 1986). However, education has adopted many of these technologies and localized change has taken place. The process that has facilitated change is similar, in many aspects, to the processes that are necessary to facilitate systemic change. The process is one of mentoring and change facilitation. A major challenge facing academic institutions is to train teachers and staff to integrate technology within their professional lives and within their classrooms. The ultimate goal for systemic change in education is this seamless integration of technology in the classroom.

The purpose of this study was to use the Concerns-Based Adoption Model (CBAM) to evaluate the possibilities of facilitating this systemic change effort through entry level teachers (Teachers moving from the pre-service learning environment to first-year teachers). This study involved identifying pre-service teachers concerns about integrating technology into the classroom and their ability to integrate technology into their instruction, as well as the identification of critical attributes of the effective integration of technology into the classroom.

Methodology

Subjects

Subjects consisted of 27 pre-service teachers teaching in urban public schools along the Front Range, in Colorado. The student teaching program is designed to mentor the development of effective teaching strategies and the use of technology in the classroom by pre-service teachers. The program utilizes an on-site cooperating teacher and a consultant from the university to mentor the student teacher. The mentor's work is supplemented by seminars which the student teachers attend bi-monthly during the semester. Further, the university consultant visits the student teacher a minimum of six times during the semester and evaluates the student's teaching during a minimum of four of those visits. A standardized form is used to evaluate the student's teaching and is designed to provide the student with constructive feedback, both positive and negative.

Instrumentation

In their book *Change in Schools* (1987), Gene Hall and Shirley Hord state that change is a process not an event. This is a process that requires time, support, attention to concerns, facilitation, and a map of the desired outcome. The components of the Concerns-Based Adoption Model (CBAM) were designed by Hall and his colleagues at the University of Texas. The diagnostic components of CBAM are designed to facilitate the change and adoption process. Change not only encompasses technical problems associated with the adoption of an innovation, but also the personal needs of the potential adopter.

The CBAM model includes three diagnostic dimensions: (a) Stages of Concern (SoC), (b) Levels of Use (LoU), and (c) Innovation Configuration Map (ICM). Stages of Concern address the intensity of the feelings and perceptions that the individual adopting the technology is expressing. Concerns are identified in seven different areas. Levels of Use address the behavior related to how the individual uses the technology, with eight distinct levels identified. Specific behaviors are associated with each Level of Use. Finally, Innovation Configuration Maps involve the development of word maps that describe the operational components of an innovation and how each can be adapted, or in some cases mutated. In the following sections each of the diagnostic procedures associated with CBAM are described in greater detail and the methodology used in this study is explained.

Stages of Concern

SoC has been used extensively in concern's research involving many different innovation adoption situations. According to Hall and Hord (1987) the process of change can be more successful if the "concerns" of the individual are considered. The concept of "concerns" can be defined as: "The composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (Hall, George, & Rutherford, 1979, p. 5). The Stages of Concern theory provides a means to assess different perceptions toward systemic change. The SoC Questionnaire (SoCQ) provides a quantitative measure of the intensities of the seven Stages of Concern dimensions (see Figure 1).

6 REFOCUSING: The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.

5 COLLABORATION: The focus is on coordination and cooperation with others regarding use of the innovation.

4 CONSEQUENCE: Attention focuses on impact of the innovation on student in his/her immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.

3 MANAGEMENT: Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.

2 PERSONAL: Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.

1 INFORMATIONAL: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.

0 AWARENESS: Little concern about or involvement with the innovation is indicated.

Figure 1. Stages of Concern About the Innovation.
(Hall and Hord, 1987, p. 60)

Internal validity of the SoC instrument was examined using Cronbach's alpha procedure on a large sample of data (N = 830) involving teachers and professors who expressed their concern about an innovation. Alpha coefficients ranged from .64 to .83, and test-retest correlations ranged from .65 to .86. This would indicate that the instrument had internal consistency and stability for each of the seven Stages of Concern (Hall, George, & Rutherford, 1979, 1986).

SoC Methodology

During the course of this study, SoC Questionnaires were administered to participating student teachers on three separate occasions. The questionnaires focused on the student teacher's concerns about integrating technology within the classroom. Questionnaires were administered during the student teacher's regularly scheduled seminars. The first questionnaire was used to establish a set of baseline data; the remaining two questionnaires were used to determine how their concerns changed during the course of their student teaching experience.

Innovation Configuration Map

In their initial studies, Hall and his colleagues identified a phenomenon that is generally not acknowledged when dealing with change processes. Users of innovations tend to adapt and, in many cases, mutate innovations. Although the innovation may be identified with the same name, it may bear no resemblance to the ideals of the developer. Innovation Configuration Maps address this probable situation.

Hall and Hord (1987) have developed special procedures for "mapping" the different configurations of an innovation. IC Mapping is innovation specific. To begin the IC Mapping process, materials must be reviewed and the developer(s) interviewed. The primary task is to identify the operational components and the behavioral tasks associated with the innovation. Next the variations of each component need to be identified. The overall goal of IC Mapping is to develop a word map that identifies optimal conditions as well as adaptations and mutations of the innovation. This results in a concept map of the innovation.

ICM's provide new insights into the innovation and aspects for its use, which help to clarify the multiple forms that an innovation can take and act as a guide for facilitating the change process. They provide word pictures of the different ways in which the innovation can be used and a basis for judgments about the effectiveness of an innovation. In order to bring about systemic change, it is crucial to document that "acceptable" configurations of the innovation are in use. The IC Map provides a device for assessing where "users" are when used in conjunction with Levels of Use (LoU).

ICM Methodology

In constructing the ICM a broad definition of technology was used initially. A brainstorming process was used to incorporate the experiences of teachers currently integrating technology within the classroom. Teachers and professors were interviewed regarding their perceptions of technology use in the classroom. Concept maps were then created and merged with the data obtained from the brainstorming sessions.

The Levels of Use Concept

Levels of Use provides a key ingredient for understanding and describing implementation of an innovation. Data collected from LoU interviews can provide useful insights about staff development, evaluation, planning and facilitation for leaders and change facilitators. Levels of Use gives the leadership and change facilitator a yardstick to monitor the rate of change. By understanding Levels of Use in systemic change, leaders and facilitators can provide appropriate interventions for each user based on the user's LoU category. According to Hall and Hord (1987) Levels of Use focuses on the behaviors that are or are not taking place in relation to the innovation (see Figure 2). The Levels of Use definitions presented in Figure 3 include three "nonuser" descriptions and five "use" descriptions. When Hall and associates defined the levels, heavy emphasis was placed on developing definitions of what could be observed with each level representing different behavioral approaches. For example, a person at Level of Use 0, Nonuse, is not looking at, reading about, using, or discussing the innovation.

VI RENEWAL: State in which the user reevaluates the quality of use of the innovation, seeks major modifications of or alternatives to present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system.

V INTEGRATION: State in which the user is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence.

IVB REFINEMENT: State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short- and long-term consequences for clients.

IVA ROUTINE: Use of the innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.

III MECHANICAL USE: State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.

II PREPARATION: State in which the user is preparing for first use of the innovation.

I ORIENTATION: State in which the user has recently acquired or is acquiring information about the innovation and/or has recently explored or is exploring its value orientation and its demands upon user and user system.

0 NONUSE: State in which the user has little or no knowledge of the innovation, no involvement with the innovation, and is doing nothing toward becoming involved.

Figure 2. Levels of Use of an Innovation
(Hall and Hord, 1987, p. 84)

Excerpted from: The LoU Chart: Operational Definitions of Levels of Use of the Innovation Austin: Research and Development Center for Teacher Education, The University of Texas, 1975.

Levels of Use Profile

Typically a person will move in sequence from Level of Use 0, Nonuse, to Level of Use IVA, Routine, assuming that the innovation is appropriate, the leader and other change facilitators fulfill their roles, and time is provided. Activities associated with the "nonuser" range from doing nothing to gathering information in preparation to use the innovation. Once the user has reached Level II and is prepared to adopt the innovation, they are prepared to move to the "user" categories.

The first use of an innovation tends to be disjointed and erratic. Most new users cling to the users guide and concentrate on the day-to-day uses more than considering long term uses. Hall and Hord (1987) indicate that individuals typically remain at the mechanical level for an extended period of time. As the user becomes quite experienced, they move into Level of Use IVA, Routine. Once a user reaches a Routine Level of Use they typically fall into a comfortable pattern for using the innovation. As users move toward the higher Levels of Use IVB, Refinement; V, Integration; and VI, Renewal, adaptations are intended to improve the effectiveness and positive outcomes from using the innovation. The focus is now on increasing effects with students.

LoU Methodology

In this study, one LoU Interview was conducted with each student teacher at the conclusion of their student teaching experience. Interviews were conducted at this time to determine their Level of Use upon exit. The student teacher's Level of Use will, in part, determine their ability to facilitate systemic change when they enter the teaching profession.

Data Analysis

The data analysis procedures followed in this study were a combination of quantitative and qualitative methods. A comparison of means was used to analyze the scores obtained from the SoC. The LoU Interviews were scored using a rubric created by Hall and his associates at the University of Texas. The data obtained from individual student teachers were compiled and comparisons made between student scores. Trends were identified and outliers explored in greater depth.

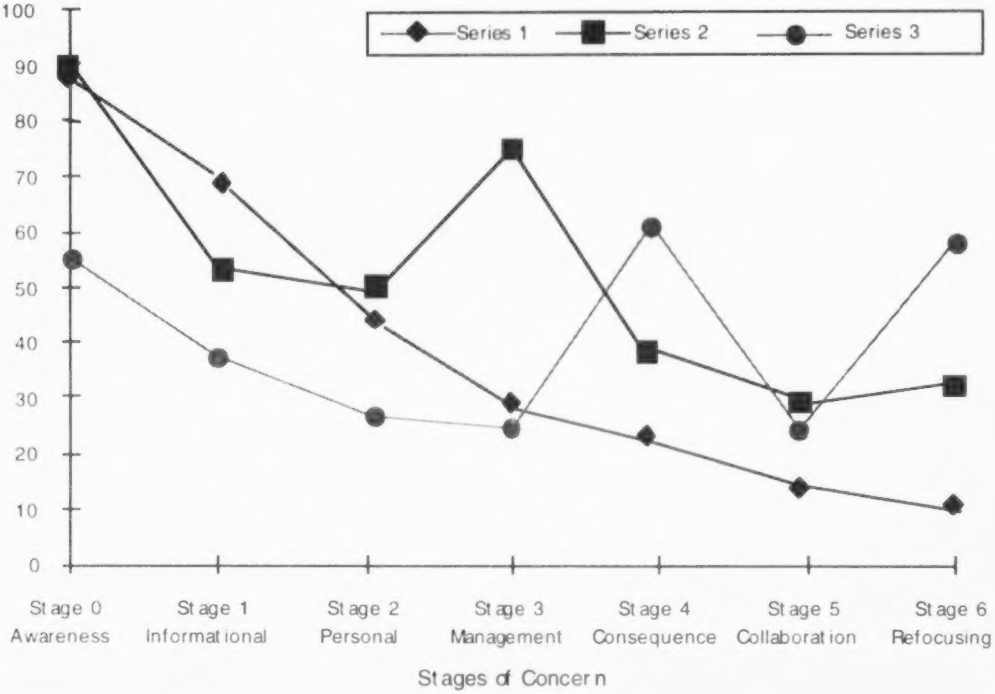
Results

SoC

For students entering the student teaching experience, their Self concerns (awareness, informational, and personal) were high (see Series 1 of Figure 3). Task and Impact concerns were less evident. Previous research (Hall & Hord, 1987), indicates that this should be expected. "Concerns at this point have to do with feelings of potential inadequacy, self-doubts about the knowledge required, or uncertainty about the situation they are about to face. Typical statements reflecting these types of concerns are: 'I wonder if I know enough to teach them.' 'Will I be able to control them?'" (Hall & Hord, 1987, p. 57).

The results of the second SoC indicated higher Task concerns (management). This instrument was administered midway through the semester (see Series 2 of Figure 3). As student teachers transition into the role of teacher, concerns regarding: logistics, classroom management, and preparation are expected to increase (Hall & Hord, 1987). As students begin to observe the new role of the student teacher, they place added demands on the student teacher's time and on their ability to manage the classroom.

As the student teachers progressed through their student teaching experience, Impact concerns (consequence, collaboration and refocusing) increased in intensity (see Series 3 of Figure 3). "Ultimately, teachers can become predominately concerned about how their teaching is affecting students and about how they can improve themselves as teachers" (Hall & Hord, 1987, p. 57). At the conclusion of the experience their overall concerns regarding instructional technology were all intensified.



ICM

Initially the ICM was developed to identify both effective teaching strategies and technology in the classroom. Each map described the optimal and desired behaviors that the teacher was to exhibit if the technology was used at LoU IVA, Routine. During the course of the initial LoU interviews, the ICM had to be redesigned to look at hard technologies instead of a more broad view of technology. The final version of the ICM included a checklist of technologies designed to assess the availability of specific technologies in the classroom as well as a word map that behaviorally defined the use of those technologies.

LoU

Upon exiting their student teaching experience, the student teachers' LoUs ranged from Level I through Level IVA. The percentage of nonusers were 20%, while the users were 80%. However, the heaviest grouping of users were Level III, Mechanical, at 54%. The remaining student teachers were at Routine LoU. Only 26% of the student teachers are positioned as entry level teachers to facilitate systemic change.

Discussion

Without a doubt, technology will continue to advance and people must be supported in the adoption process. Educators must harness the power of technology to aid and assist their instructional endeavors. Only when technology has advanced to become an integral part of the teacher's instructional repertoire will we see the advantages that technology can provide. For technology to become an integral component of the educational classroom environment and learning process of our schools, teacher preparation programs and school districts must provide the necessary support to help teachers to develop the skills essential to prepare their students to compete in a technologically based society. There are two aspects of support that need to be considered: technical support -- aimed at establishing and maintaining connectivity -- as well as curriculum support. Curriculum support would provide for teaching materials, documentation for teachers and students, location of sources of potential benefit; suggestions about integrating resources into the curriculum, and inservice training aimed at facilitating integration. Teacher education programs and school districts that implement or emphasize only one type of support are not likely to succeed (Maddux, 1994). This is a process that should begin with student teaching and extend through the first few years of actual teaching.

It has been argued that students leave college and adopt the methods of the institution at which they are hired, forgetting what they learned in college. They leave college using the skills they have learned at a mechanical level of use. This level of use is easily deteriorated (Hall & Hord, in press). Mechanical level users fall back on their most comfortable method. Unfortunately these methods are not always the most productive. To ensure that novices progress beyond a mechanical level of use, a procedure for mentoring them in the continued use of instructional technologies needs to be instituted.

Currently, education is not meeting the needs of society (Fad & Ryser, 1993; Superintendents, 1988; LeBaron & Bragg, 1994; Wirth-bond, Coyne, & Adams, 1991). There is a lack of technological integration within teacher education today. Teacher education programs need to provide instruction for teachers that facilitates the integration of computing technologies into the classroom and their professional lives. A routine level of use better ensures the integration of technology in the classroom (Hall & Hord, in press). To achieve this end, a plan for viewing how technology is integrated within the classroom needs to be developed. This study has presented a perspective for facilitating systemic change by way of integrating technology within the teacher preparation program. The study also elicited valuable information for developing specific interventions to be used with pre-service teachers. The components of CBAM can be used to bring about systemic change in education. Concerns and use data and the prescribed interventions along with the mentoring of pre-service educators can provide a foundation for a ground-up approach to effect systemic change in education.

In their efforts to bring about systemic change in education, educators and instructional designers need to use technology to assist in instructional management and improvement, communication with both peers and experts in their fields, and identification of new instructional methods and resources. These tools will help teacher's create instruction that promotes self-regulatory learning behaviors such as coping strategies, problem-solving and decision making skills, goal setting, and planning.

Future Research

Student teachers have provided a baseline group from which to launch further study. This baseline group has provided the beginnings of a longitudinal study regarding the student teacher's adoption and retention of the technologies included in this study. Future studies need to look at the Levels of Use at the cooperating teacher level and include a LoU interview at the beginning of the student teacher experience. This will allow researchers to take into account the mentoring process that occurs during the student teaching experience. Other avenues to consider include: (a) a longitudinal study designed to follow student teachers through their first few years in the classroom, (b) university faculty and their use of technology in the classroom, as well as in their professional lives, and (c) school district efforts to integrate technology.

Systemic change is a process that requires time, collaboration, flexible leadership, and facilitators who understand all aspects of the change process. From the research conducted in this study there is an indication that in order to facilitate systemic change, student teachers need to be better prepared to enter the classroom. To achieve this end, CBAM should be used as a tool to assess and facilitate the progress of student teachers in reaching a routine LoU in the integration of technology within the classroom. The theory, research, and instruments offered by CBAM provide a valuable tool for evaluating and facilitating systemic change.

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Title: Technological Framework
for Network-Based Distance Education

Author: Jong-Yeon Lee

Technological Framework for Network-Based Distance Education

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Samsung Data Systems

1. Introduction

The growth of the information industry and new computer technologies enables us actual use in the field of education and training. Among these high technologies, educators have concentrated on multimedia and telecommunications, developing practical programs for instruction. Multimedia is now recognized as a basic technology for developing and using educational software. Our attention has moved from stand-alone computer systems to integrated systems which include CD-ROM and interactive video. Furthermore personal desktop multimedia systems can be linked with other systems through computer networks, enabling free exchange of various types of information such as text, images, and voice. Interpersonal computing is beginning to replace personal computing.

However, most discussion and development relating to the above technologies emphasize their mechanical capabilities rather than their educational potential. Technology alone cannot provide the answers when we deal with human activities such as learning and instruction. 'The task, the culture, the social structure, and the individual human are all essential components of the job, and unless the computational tools fit 'seamlessly' within this structure, the results will be failure' (Norman, 1991). In order to derive educational improvement from the technologies, we need to establish and use a sound conceptual and technical framework for the development of educational programs. It is especially important in relation to the super high-speed information network being constructed by the Korean government. Unless we establish theoretical background and integrate fundamental and common technologies for educational applications, it will be difficult to enhance the quality and productivity of educational programs and ultimately to improve public welfare.

This study identifies the basic technologies necessary for distance education and specifies their content and scope. The term, "distance education" in this paper means high-speed network-based interactive instruction and learning systems and is different from the existing distance education systems in many aspects. The characteristics of the existing systems are that instruction and learning activities take place with pre-made printed materials, broadcasting, and audio and video tapes. The limitation of these systems is that the learner has no personal contact with other students and that it is difficult for teachers and students to exchange their opinions and feelings. Since education is primarily performed by interactions between students end teachers, we need to increase the opportunities for educational interaction. In fact, instructors have made an effort to link the learners and instructors by applying communication techniques such as facsimile, computer-mediated communication and video and audio conferencing to the learning process. Among mediated two-way communication systems, high-speed information network or B-ISDN(Broadband Integrated Service Data Network) is expected to be the most powerful one. Therefore, to maximize the effectiveness of high-speed networks in education, we need to establish conceptual backgrounds and develop fundamental and common techniques for designing and implementing distance education systems. Otherwise, we will repeat the same mistakes as we have done with the previou technology. When we have the theoretical and technical infrastructure, its usefulness will be enormous:i will be used every time an application system is developed in various fields of education and training i schools, industry, the army, hospitals, and the home.

II. Basic Concepts of Distance Education

A. Definition

Distance education is not a new concept, but one which developed from the 18th century when a stenography lesson was offered by mail in Boston. Distance education is an instruction delivery system mediated by print, audio and video materials, and broadcasting without face-to-face interact on between instructors and students. The characteristics of distance education include an absence of personal interaction, dependence on individualized learning materials, two-way communication through various media, a large number of students and their individualized learning, and it own supporting system which is different from conventional systems(Education Ministry of Korea, 1994).

Distance education has developed as new communication technology evolves. It is divided into 3 generations based on the technology used. The first generation was based on mail, the second on mass communication such as broadcasting. The third, interactive distance education, has electronic telecommunication technology as its basis. This paper focuses on the third generation and discusses its advantages and disadvantages.

The third generation distance education systems are also divided into several types depending on underlying telecommunication technology. The most economical and most quickly implementable type is based on PSTN(Public Switched Telephone Network). It provides very primitive asynchronous tutorials in which the students download instructional contents to their computers, study them, and ask questions to teachers o program providers by using e-mail and bulletin boards. It is a very popular form of distance education internationally. The types of distance education systems which draw our attention most today are interactive video-based distance lectures and computer-based multimedia distance education systems. This paper discusses these two types of distance education in more detail.

B. Distance education based on conferencing technology

1. Video-Conference-Based Distance Education

Interactive video-based distance lectures are based on existing analog cable TV broadcasting technology. The basic hardware includes a CODEC which converts analog audio and video signals into digital

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ones, video cameras, TV monitors and audio sets. ISDN, satellite, and coaxial and optical cables are used for communication. Figure 1 shows the the structure of general systems. This system requires very expensive hardware and equipment, but not complex software. It has a short construction time which counts for its international popularity.

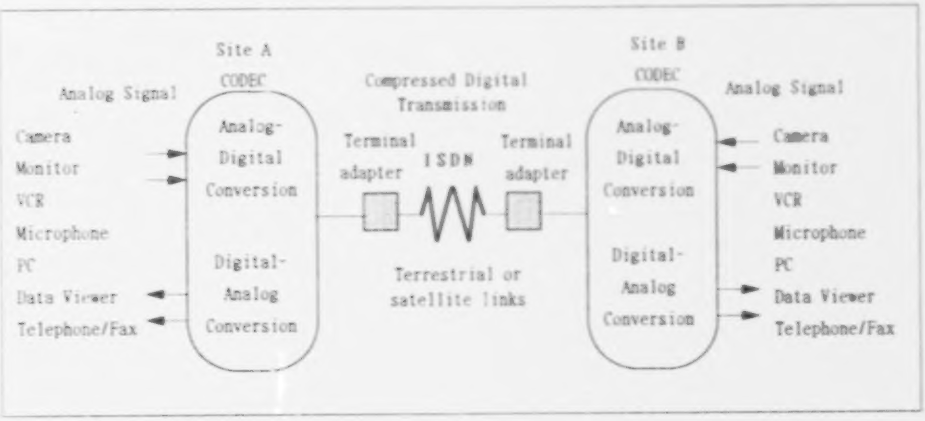
Site A
CODEC
Analog Signal
Camera
Monitor
VCR
Microphone
PC
Data Viewer
Telephone/Fax
Analog-Digital Conversion
Digital-Analog Conversion
Compressed Digital Transmission
Terminal adapter
ISDN
Terminal adapter
Terrestrial or satellite links
Site B
CODEC
Analog Signal
Analog-Digital Conversion
Digital-Analog Conversion
Camera
Monitor
VCR
Microphone
PC
Data Viewer
Telephone/Fax

Figure 1. Configuration of General Distance Video-lecture

From the educational point of view, the distance lecture essentially shares the advantages and disadvantages of the conventional lecture where an instructor teaches many students at a specific time and space. The teaching and presentation skills of the instructor(including interaction strategies with students) affect the successfulness of the system, even more so since the instructor may accommodate more students than in the conventional setting. The instructor should also be able to operate the related broadcasting and computer equipment and software. The superiority of distance lectures over the conventional ones is that it can accommodate more learners in multiple classrooms that are separated geographically, yet all students still have the opportunity to ask realtime questions to the teacher. This advantage is especially important when qualified instructors are insufficient.

However, individual students still need to leave their working site or home and go to the nearest distance education classroom. They cannot completely be free from time and space considerations. Additionally, interactions between the teacher and student are very limited. First of all, students have fewer chances for interaction and it is difficult to provide various educational interactions such as that between learners. Finally, it cannot promise the effectiveness and efficiency which can be provided by individualized learning systems since it is still a group learning system based on 1:N interaction.

2. Computer-Based Multimedia Distance Education System

The computer-based multimedia distance education system can be offered as a solution for most problems of the video-conference-based systems. This system is an educational application of computer- or desktop conferencing technology. Its basic configuration has the teachers' and students' individual computers linked via high-speed networks. Through the network, they can also access digital libraries and educational databases containing numerous learning materials and programs. Teaching can be in various instructional forms such as individualized learning by accessing the appropriate materials stored in educational databases, virtual attendance at experts' lectures, and collaborative learning by discussion between learners in different places. Now students are completely free from the time and space considerations to learn materials and develop necessary skills. It is possible for teachers or course developers to collaborate to create quality educational programs efficiently. As they can can provide natural, individualized, and flexible educational interactions, they can be expected to be the most widely used instructional delivery system along with the use of high speed computer network technology.

However, computer-based distance learning systems cannot be implemented simply by building the physical infrastructure such as network and broadcasting equipment. They require software technology to support various learner and teacher interactions, process multimedia effectively, and link to databases. Moreover, the theoretical backgrounds and design principles to maximize the potential of this new flexible educational applications are not currently available. Therefore, it will take considerable time to implement computer-based multimedia distance education systems based on a generalized and sound conceptual and technical infrastructure. Although there are few example of its application in Korea, its educational potential has been recognized along with the construction of Information Super Highway in Korea.

III. The Current Status of Distance Education Using Conferencing Technology in Korea

In Korea, it is popular to implement interactive video-based distance education systems. Although there is little technical problems, the hardware is expensive. A representative case of the systems is that of Hongchun, a sparsely populated city in Korea. This system connects 5 elementary schools in Hongchun. The major purpose of the system is to solve the problems of multi-lesson in which a teacher deals with 2 or 3 different grades in a single classroom. Figure 2 shows the overall configuration of this system.

The goverment selected Korea Open University as a model distance college education institute. It applies an interactive video-based distance education system to deliver lectures located in one learning center to students who are separated from the instructor geographically. Figure 3 shows the overall configuration of this system. The purpose of the system is to provide more student-oriented and interactive distance education programs, to improve the quality of education services, to investigate the use of information super highway in the area of education, and to increase the educational opportunities for the public.

Many other cases of interactive video-based distance education in Korea are related to college education and are summarized in table 1. Many large companies in Korea are also using or planning to use distance education systems to improve the quality and quantity of employee or customer training programs.

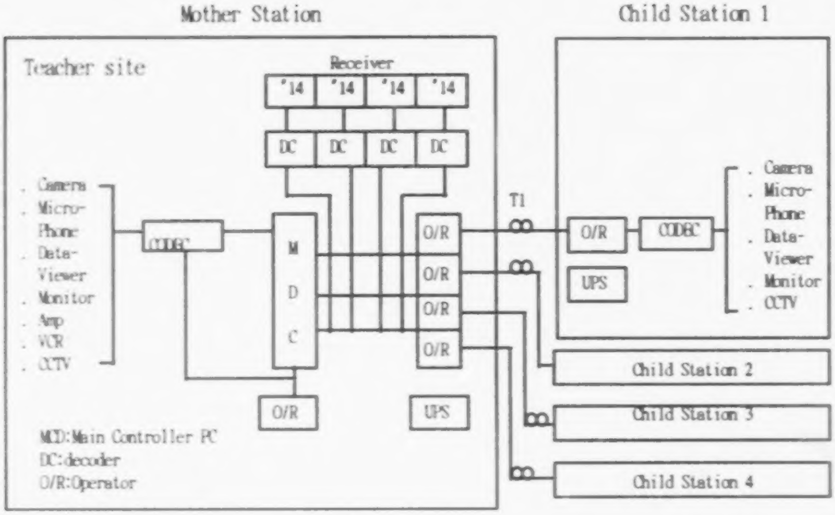
Mother Station
Child Station 1
Teacher site
Receiver
'14
'14
'14
'14
DC
DC
DC
DC
. Camera
. Micro-
Phone
. Data-
Viewer
. Monitor
. Amp
. VCR
. CCTV
CODEC
M
D
C
O/R
O/R
O/R
O/R
T1
O/R
CODEC
UPS
. Camera
. Micro-
Phone
. Data-
Viewer
. Monitor
. CCTV
Child Station 2
Child Station 3
Child Station 4
O/R
UPS
MCD:Main Controller PC
DC:decoder
O/R:Operator

Figure 2. System Configuration of Distance Education Testbed Linking Elementary Schools at Hongchun

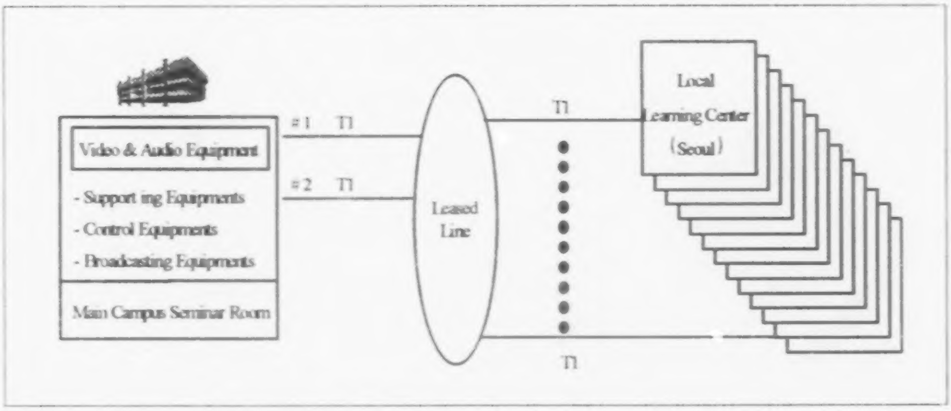
Video & Audio Equipment
- Supporting Equipments
- Control Equipments
- Broadcasting Equipments
Main Campus Seminar Room
#1 T1
#2 T1
Leased Line
T1
T1
Local Learning Center (Seoul)

Figure 3. System Configuration of Korea Open University

Name of Institute	Starting Date	Application Area/ Purpose	System Configuration
Seoul National University	5/94	Course offering in liberal arts & sciences	Seoul National Univ.-International Studio -R&D Institute
Yonsei University	12/94	MBA course offering	Yonsei Uni. Management Gradute School-Sambo Computer Inc.
Suwon University	9/94	International course offering	Suwon Univ.-Univ. of Utah
Elementary School in Hongchun	3/95	Solution to Multi-lesson	5 Elementary Schools at Hongchun
Korea Open University	11/95	Replacement to attendace-required courses	Korea Open Uni. main campus-13 local learning centers
Samsung Group	6/96	Technology education, HRD, Public Service	Samsung Group-High-quality Universities in Korea-Foreign Experts
Daewoo Group	4/95	MBA course offering	Daewoo Group-Univ. of Michigan

Table 1. Representative Cases of Interactive Video-Based Distance Education in Korea

There are few cases of computer-conference based distance education in Korea. However, along with the construction of the information super highway in Korea, its educational potential has been recognized and its underlying technologies have been developing. Among those technologies, there is DOORAE(Distributed Object Collaborative Environment for Interactive Multimedia Service) developed by Hwang(Hwang, 1995). It is an educational application of computer-conferencing technology and a software platform to implement distance education systems. Its outstanding capability is what allows various interactive collaboration between teachers and students. This platform has been applied to constructing the educational infrastructure for Sungkyunkwan University. In order to be a complete tool for implementing distance education systems, the following functions should be added: interfacing with educational databases, more sophisticated multimedia data editing, and application sharing.

Most distance education systems developed so far concern only the construction of hardware systems and the development of application systems that will be directly accessed by end users. However, along with this effort we should also develop basic and common technologies which will be used whenever we develop application systems. This approach will allow us to exclude the redundant investment in developing underlying technologies for each application and to enhance the productivity and quality of application systems.

IV. The Goal of Technological Framework for Network-based Distance Education

A. The Plan for Constructing B-ISDN in Korea

To set the goal of technological foundation for distance education, it is necessary to understand the plan for building B-ISDN in Korea. Table 2 shows the construction plan summary for the information super highway in Korea. Data transmission rates will steadily increase from 155Mbps to 100Gbps. Service areas will expand from business areas to the general public.

	Phase 1 (1995 - 1997)	Phase 2 (1998 - 2002)	Phase 3 (2003 - 2007)	Phase 4 (2008 - 2015)
Baud Rate	155 - 622 Mbps	2.5 - 10 Gbps	100 Gbps	More than 100 Gbps
Service Areas	Business areas	Extended business areas	Public residence areas	Extended public residence areas

Table 2. Construction Plan Summary for the Information Super Highway in Korea

B. The Characteristics of Technological Framework for Computer-Based Multimedia Distance Education

Network-based distance education systems are based upon the integration of technologies related to education and computer networks. Because it is a delivery strategy of education, it should be based on education-specific technology such as theories of learning and instruction and general principle and procedures for designing and implementing educational programs. Also, since it is operated on a computer network, it is necessary to use fundamental network-dependent computer technology about user-interface, information-processing, database systems, and networking. Figure 4 shows the technologies necessary for network-based education.

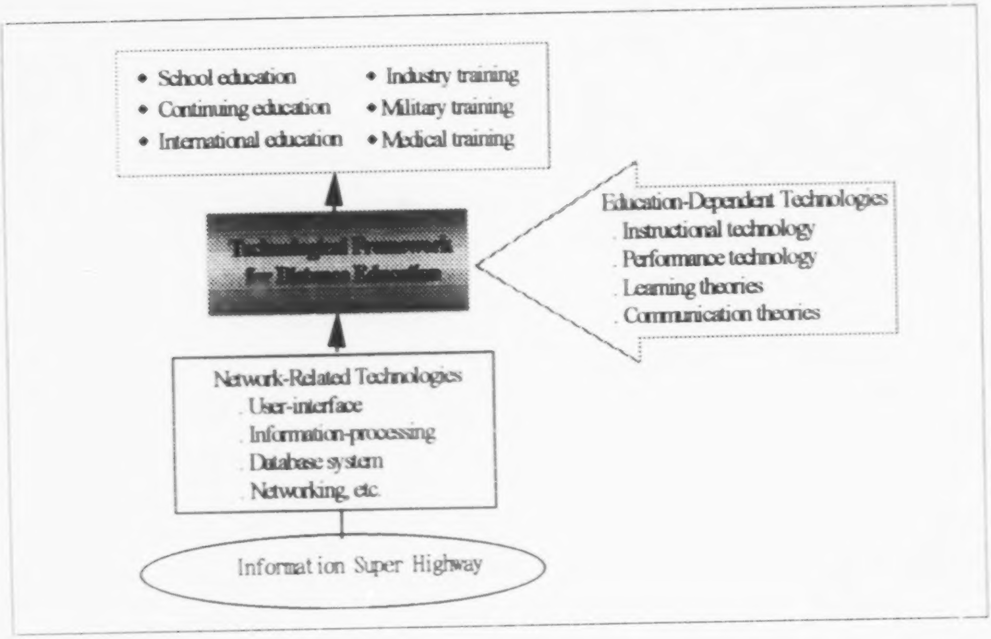
• School education
• Continuing education
• International education
• Industry training
• Military training
• Medical training
Technological Framework for Distance Education
Education-Dependent Technologies
. Instructional technology
. Performance technology
. Learning theories
. Communication theories
Network-Related Technologies
. User-interface
. Information-processing
. Database system
. Networking, etc.
Information Super Highway

Figure 4. Technologies Related to Computer-Based Multimedia Distance Education

C. The Goals of Network-based Education

The goals of developing a conceptual and technical foundation for distance education differ for each stage of construction plan. The first phase(1995-1997) is intended to design and implement distance education based on multimedia database systems and to accomplish distributed individualized learning. Figure 5 shows the configuration of the first phase. Learners can share educational information and there will be limited communication between learners and instructors through electronic-mail.

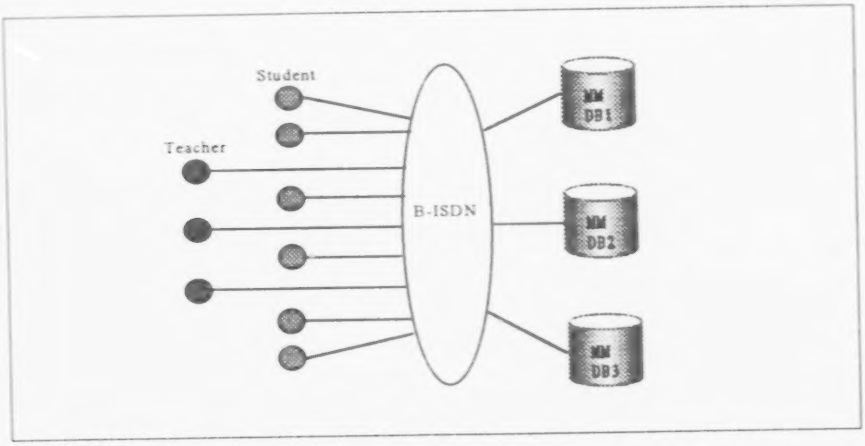
Student
Teacher
B-ISDN
MM DB1
MM DB2
MM DB3

Figure 5. Multimedia Database System-Based Distance Education

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The goal of the second period(1998-2002) is to design and implement distance education based on real-time interpersonal computing and to accomplish distributed cooperative learning. Instructors can easily access numerous multimedia database systems through their global and local managers and freely communicate with each other. Also it is possible to group users in various ways, such as student-controlled grouping, teacher-controlled grouping and system-controlled grouping. Figure 6 shows the configuration of the second phase.

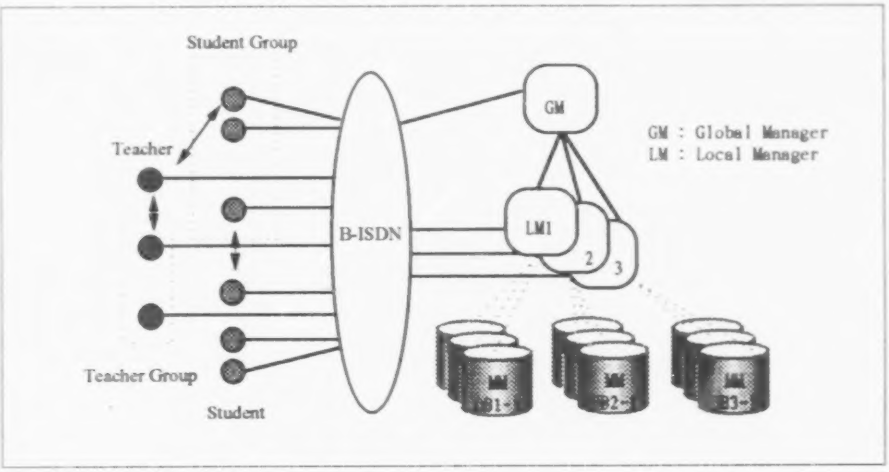
Student Group
Teacher
GM
GM : Global Manager
LM : Local Manager
B-ISDN
LM1
2
3
Teacher Group
Student
MM
DB1-
MM
DB2-1
MM
DB3-

Figure 6. Real-time Interpersonal Computing for Distance Education

The third phase(2003-2007) is intended to design and implement distance education based on intelligent network and to accomplish distributed adaptive learning in which instruction is provided based upon a user's history, need, and personal characteristics such as aptitude and personality. The intelligent interface brings user-friendly interactions between learners and systems and even extends educational services to disabled learners. Figure 7 shows the third phase configuration.

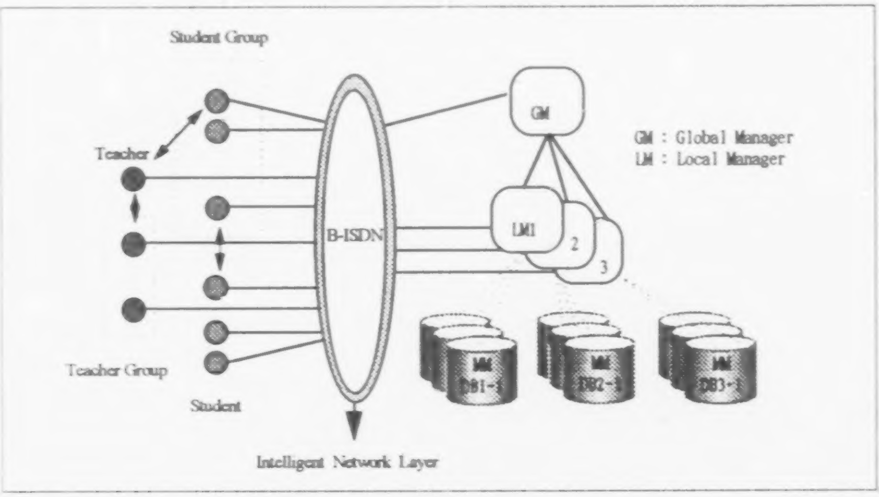
Student Group
Teacher
GM
GM : Global Manager
LM : Local Manager
B-ISDN
LM1
2
3
Teacher Group
Student
MM
DB1-1
MM
DB2-1
MM
DB3-1
Intelligent Network Layer

Figure 7. Configuration of Intelligent Distance Education

The goal of the fourth phase(2003-2007) is to design and implement distance education using virtual technology and to accomplish distributed realistic learning which appeals to all human-senses. It is possible to represent virtual classrooms and virtual schools. Figure 8 shows the configuration of the fourth phase.

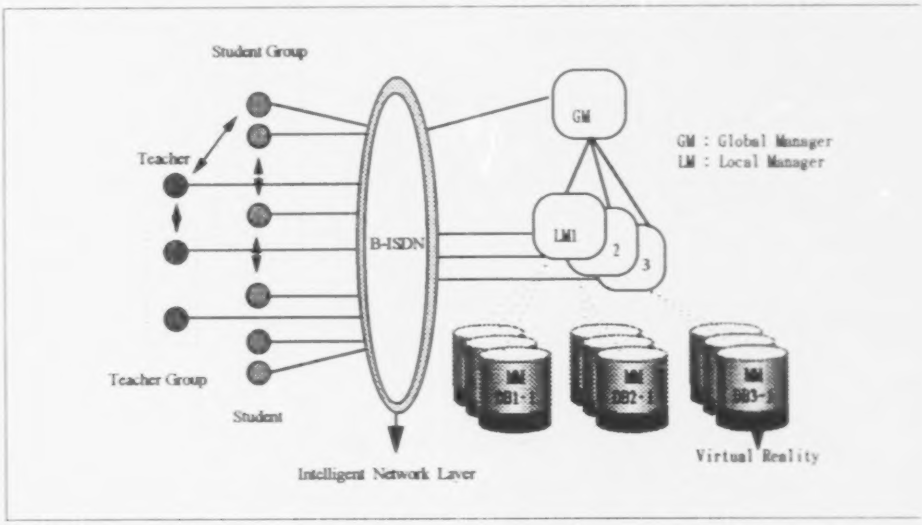

Figure 8. Virtual Reality-Based Distance Education

V. The Content and Scope of the Component Technologies Supporting Distance Education

A. Educational Service Modeling

Technology supporting distance education consists of 4 parts: modeling of educational services, courseware authoring, structuring and storing educational information, and educational user-interface.' Modeling educational services' includes the development of theories and guidelines necessary to design and develop various network-based education systems. 'Courseware authoring' technology allows users to design and develop various types of network-based courseware without expert knowledge or skills on networking, programming and instructional design.'Structuring and storing educational information' technology includes what is necessary to structure educational materials based on their characteristics and to store them as an integrated educational database system. This technology assures the efficient retrieval of educational materials. 'Educational user-interface' technology helps users to interact with the system easily in retrieving and using educational materials stored in the database systems. Figure 9 shows the 4 component technologies supporting distance education

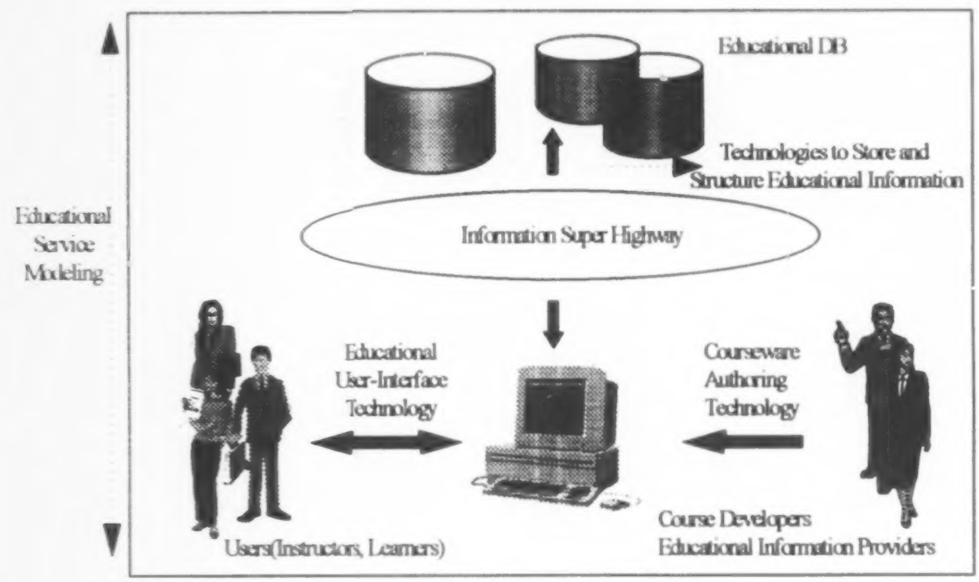
Educational DB
Technologies to Store and Structure Educational Information
Educational Service Modeling
Information Super Highway
Educational User-Interface Technology
Courseware Authoring Technology
Users(Instructors, Learners)
Course Developers Educational Information Providers

Figure 9. Component Technologies Supporting Distance Education

B. The Content and Scopes of Component Technologies for Distance Education

1. Educational Service Modeling

Network-based educational service modeling is the groundwork for developing the other three component for network-based education. In modeling the services, the concept of interpersonal computing should be emphasized. Interactivity is one of the most important instructional and learning factors in all educational and training programs. Educational interactions take place between learners and instructors, between peer learners, and between learners and learning materials. The interactions between learners and learning materials have been emphasized in the existing distance education systems using courseware and only limited interactions between instructors and learners have been possible. As telecommunication technology continues to evolve, interactions between learners and between learners and instructors are possible, thereby enhancing the effectiveness of distance education.

In modeling educational services, it is very important to develop the techniques necessary to manage the types and direction of educational interaction according to the network construction plan and the available network-related technology. The designing principles and guidelines for various network-based instructional strategies such as distributed individualized and collaborative learning need to be developed. By establishing and integrating models of subject matters and learner characteristics, the methodology for designing and implementing distributed intelligent learning systems should be provided. The specification of educational environments which can be enhanced by applying virtual reality technologies should be presented and the designing principles and guidelines for creating and implementing virtual classrooms are expected to be provided. In modeling the services, we must always consider the three aspects of education(learning, teaching and authoring). All three principles and guidelines should be stored in a database systems so that everyone is able to reference them readily.

2. Courseware Authoring Technology

In order to improve the quality and productivity of network-based courseware, authoring technology should be developed and provided for users as an easy-to-use software tool. This technology can be developed by applying educational needs to fundamental software technologies related to multimedia data processing, object-oriented databases, artificial intelligent including expert systems, and multiuser interfaces.

To specify the content and scope of courseware authoring technology, it is first important to provide the utilities for interfacing with educational multimedia database and distributed learning management systems. By developing the MHEG(Multimedia and Hypermedia Expert Group) engine, we need to improve the capabilities of processing multimedia information. Also a graphical user-interface, providing a meaningful and easy-to-use for both courseware authors and learners, should be developed. The authoring utilities for supporting various educational interactions are important and it is necessary to provide the multiuser-interface for collaborative works such as distance lecture, cooperative learning, and collaborative authoring. It is important to support the development of intelligent tutoring systems in distributed environments. It is also necessary to provide the engines for storing expert modules containing domain knowledge and problem-solving rules, learning strategy module containing instructional strategy and diagnosis and prescription rules, and learner model modules containing each individual's performance history, aptitude, and personality factors. It is also helpful to provide a natural language based user interface for both authors and learners. When virtual reality technology is readily available, it is important to develop a human sense-based user-interface for both authors and learners and to provide the utilities for activating virtual reality equipment, delivering telepresence, editing and rendering real-time animation, and implementing holograms.

3. Technology to Store and Structure Educational Information and Materials

When using stand-alone computer-based education systems, we can use courseware without any intervention once it is developed. However, once educational material is developed in a network-based environment, it is stored in a database and then retrieved when needed. Therefore educational materials should be systematically structured and stored so that the correct material for the user's needs and characteristics can be easily retrieved.

An index engine for educational multimedia and hypermedia information and an automatic analyzer and classifier of the internal and external structure of information needs to be developed. The advanced synchronization model to present multimedia information in various ways in learning processes needs to be provided. To support instructional activities for teachers, navigation and browsing tools should be provided. In order for educational information providers to revise and update educational materials, a version manager is required. It is also necessary to model educational multimedia databases and to develop navigation techniques in hypermedia systems. Real-time interpersonal educational information, should be based on the same properties as those for the multimedia and hypermedia information should be developed based upon its properties. To link distributed multimedia database systems efficiently, local and global managers must be developed. For the intelligent and virtually realistic information, the same techniques mentioned above need to be developed based upon its characteristics and requirements.

4. Educational User-interface Technology

Since most learners and instructors have no expert knowledge or computer or telecommunication skills, we need to develop and provide an easy-to-use and friendly user-interface. Input and output techniques for multimedia data processing, media conversion techniques, and a protocol allowing multiple-users are necessary in developing the educational user-interface.

To specify the content and scope of the technology about educational user-interface, it is first important to provide two and three dimensional graphical user-interface supporting educational activities for non-expert users, the metaphors modeling various educational interactions, and the cognitive user-interface. It is also necessary to develop various user-grouping techniques such as learner-controlled grouping based on users' needs and system-controlled grouping based on users' performance history, aptitude, and personality factors. An interface supporting educational conversation and group discussion in cooperative learning is required. It is also necessary to develop an intelligent agent that models the learner and selects the right learning tasks for him or her. An image agent needs to be developed to direct and advise educational activities. We must develop educational natural language-based interfaces, which generate and interpret various inputs and outputs including voice, pattern, image, motion, gesture, and vision. Finally, for the databases of the techniques about real-time simulation and telepresence we need to develop an interface that guides users to create the setting of virtual collaboration without space and time constraints.

VI. Conclusion

To maximize the use of technology in education and to achieve educational improvement it is important to establish and distribute its conceptual and technical framework. Without developing the technological framework, we must invest in developing the underlying technology each time we develop application systems. The technological framework for network-based distance education includes 4 component technologies: modeling of educational services, courseware authoring, structuring and storing educational information, and educational user interfacing. Modeling educational services means establishing theories and guidelines necessary to design and develop various network-based education systems. Courseware authoring technology means what enables users to easily design and develop various types of network-based courseware. Structuring and storing educational information technology means what is necessary to structure educational materials upon their internal and external characteristics and to store them as an integrated educational database systems. Educational user interfacing technology is what enable users to interact with the system easily in retrieving and using various educational materials from the database systems.

Only the systematic development of the above component technologies can exclude redundant investmen in developing them for each application system and guarantee effective, efficient, and appealing education systems to accomplish the role of future education for society.

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The Use of Instructional Development Procedures to Create Exhibits: A Survey of Major American Museums

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The Use of Instructional Development Procedures to Create Exhibits: A Survey of Major American Museums

Museums are a major American pastime, and increasingly they are also big business. There are more than 6000 museums in this country, and it has been estimated that more people attend museums each year than attend NFL football games. It has also been estimated that for every dollar invested in museums, they generate $30 in revenue for the communities in which they are located.

Most museums also acknowledge that they have an educational as well as a recreational purpose. In recent years, the museums' educational missions have been highlighted as they compete for public funds on the grounds that they are educational institutions. Critics have pointed out, however, that museums often fail to educate. B. N. Lewis stated the case clearly when he said, "The basic problem is that the meaning and significance of the exhibits tends to be almost completely lost on the generally uninformed visitor. An exhibition may of course be full of meaning and significance to the visitor who already happens to know, in fairly close detail what the subject matter is all about" (p. 151).

The criticism has been that subject matter experts create museum exhibits that assume a level of subject matter expertise comparable to their own, when in fact most viewers of the exhibit lack the prerequisite knowledge or schema to comprehend it. On the other hand, there has been very little research on how museum exhibits in reality *are* created. Who creates these exhibits? For whom are they put together? Where do the exhibit creators start? How do they know if an exhibit is successful? Who, if anyone, is responsible for the educational quality of the exhibit? Do museums use instructional systems development or parts of the ISD process to create their exhibits?

The purposes of the research described in this paper were to describe through rigorous, empirical survey research:

1) the priority major American museums place on educational exhibits.

2) the extent to which major American museums use instructional development (ID) practices to create exhibits.

A third purpose was to compare the results of this investigation with a similar one conducted in 1986. A complete reporting of the comparative data is beyond the scope of this paper, however. When the longitudinal analysis is completed, the results will be disseminated through national conference presentations and publication.

Description of the Study

The following paragraphs describe the sampling strategy that was used in the research, the types of museums included, the survey instrument, and the response received.

Sampling Strategy

The source from which the institutions were sampled was a database supplied by the Institute of Museum Services (IMS). The sample for the survey included museums from all the various IMS categories. The sample included all institutions with annual budgets over $2 million that applied to the Institute for funding during the five years preceding the study (1990-1994), and those with an annual budget less than $2 million that nevertheless represent the largest budgets within their institution category. The latter group was included because some types of museums rarely have $2 million budgets, and to choose institutions strictly by budget size would result in the omission of these types of institutions from the study.

This sampling strategy identified 250 institutions to whom the research instrument was sent. This sample approaches population data, in that it includes nearly all of the major museums in the country. The exceptions would be private museums so well funded privately that they rarely apply for external funds. These are few in number.

Types of Museums Surveyed

The types of institutions included in the study were: aquarium, arboretum/botanical garden, art museum, children's museum, historic house, history museum, natural history/anthropology museum, nature center, planetarium, science/technology museum, zoo, specialized, general, and "other."

The Survey Instrument

The instrument used in the study included 59 close-ended and open-ended questions. The survey was organized around the major steps in the instructional systems development process. Definitions of these steps and related terminology were provided before questions about the use of these steps were asked. The research instrument was created by the authors and closely paralleled the instrument used in 1986 by Schlenk (1987) to assess the exhibit development process at that time. Major modification of the earlier instrument was precluded because an important purpose of the current research was to compare its findings with those of the previous study. Preserving this goal meant that a number of questions about concepts that have emerged in the past ten years--for example, constructivist learning environments--could not be investigated with this instrument.

Response to the Survey

One follow-up postcard reminder was sent to institutions that did not respond within the first few weeks following the mailing of the survey. The final response rate was quite good; 114 institutions returned completed questionnaires for a final response rate of 46%.

Results of the Study

As mentioned above the survey instrument included 59 questions. Therefore, the results are voluminous. This paper presents an overview of responses to some of the most fundamental questions addressing museum priorities and the exhibit development process.

Museum Priorities

Museums rank education as their number one priority; however, exhibits rank a very close second. When asked to rank educational activities, museums rank exhibits first. Museums tend to believe, however, that recreation is the primary reason why people visit them.

Exhibit Development Time

Museums take an average of 29.7 months to develop a major exhibit; the reported range is 1 to 60 months. Museums take an average of 10.1 months to develop a minor exhibit; the reported range is 0.5 to 24 months.

Use of Instructional Systems Development

The following paragraphs describe the extent to which museums reported using some of the essential steps in the instructional development process.

Overall use of ID. Results indicate that 39% of museums are using instructional development to create their exhibits. Among those who use ID, 76% consider it to be either "successful" or "very successful." Of museums not using instructional development, 22% report that they are not familiar with the ID process.

Needs assessment. Results show that 45.6% of museums include needs assessment as part of their exhibit development process. When asked how audience needs are determined, surveys (68.4%) and trends (67.5%) are reported as the most popular tools, while interviews (42.9%) are also widely employed. On the other hand, 70% of museums do not use audience characteristics data when selecting exhibit topics. Interestingly, 67% of museums believe they are responsive to their audience's needs.

Use of objectives. Only 20.7% of museums always have written instructional objectives for exhibits; 47.7% sometimes have written objectives. Of museums that use objectives for their exhibits, a mere 7.7% have objectives stated in behavioral terms.

Formative evaluation. Formative evaluation is one of the better accepted steps of the ID process among museums. Responses indicate that 40.7% of museums conduct formative evaluation of exhibits. However, only 24.6% of museums use trial runs of exhibits as a part of their exhibit development process.

Summative evaluation. Museums consider large crowds as the main indication of a successful exhibit. Further, 47% of museums make no attempt to assess what their audiences learn from their exhibits.

Instructional developers. Results indicate that 39% of museums have instructional developers on their staffs. In addition, 36% have an instructional developer working as part of their exhibit development team; 61% said they *should* have instructional developers on their exhibit development teams.

Role of the instructional developer. The museum field appears to be equally split regarding whether an instructional developer should coordinate the exhibit development process – 47.7% said "yes" while 46% said "no."

Responsibility for educational effectiveness. The staff member most likely to be charged with insuring the instructional soundness of exhibits is a museum administrator, not an educator or an instructional developer. If there is no formal position to insure the instructional soundness of exhibits, this duty falls to someone in education only 20% of the time.

Preliminary Conclusions

The data collected in this survey allow the researchers to draw several preliminary conclusions about the state of exhibit development in major American Museums. There are significant comparisons to be made with the original 1986 survey that will be published when the data is totally analyzed and the longitudinal aspects of the data are explored. The conclusions below reflect only the 1996 survey data.

Museum priorities. Given that museums rank education and exhibits as their first two priorities and consider exhibits as their number one educational activity, the conclusion might be drawn that the priorities museums ranked first and second are very closely related; they see both as education. Historically this is a major change from the original goals of most museums – to collect, preserve, conduct research, and publish scholarly writings.

Exhibit development teams. Both the quantitative and qualitative data collected with the current survey indicate that many museums view exhibit development as a team effort. However, there is a diversity of opinion about who should be a member of an exhibit development team and who should coordinate the work of such teams. A majority of respondents indicated that an instructional developer should be included as a member of an exhibit development team. Far fewer (though a sizable percentage) indicated that an instructional developer should *coordinate* the team effort. This result suggests that many museums value the contribution of instructional developers, but are not ready to turn over control of the exhibit development process to them.

Use of instructional development. The fact that nearly 40% of museums use instructional development and find it successful would indicate that instructional development should be included as a basic course in the curriculum of the museum studies programs offered by a number of universities around the United States. This fact is underscored by the fact that 22% of the museums indicated that they were not familiar with the ID process.

Evaluation of exhibits. Evaluation of exhibits is conducted through a number of means by museums. While formative evaluation of exhibits is widely used, many museums make no attempt to assess what their audiences learn from their exhibits. Yet they seem to have confidence that they are responsive to their audiences' needs. The conclusion could be drawn that museums could increase their use of formative evaluation, trial runs, and other evaluation strategies. In particular, the finding that many museums do not assess what their audiences learn from their exhibits would seem to be inconsistent with the high priorities which museums ascribe to education and exhibits. Museums would seem to accept evidence of their effectiveness that instructional developers would question.

Recommendations from the Survey Results

Exhibit topic selection. Museums should make greater efforts to consider their audiences' needs when selecting and developing exhibit topics.

Instructional development. Teach ID as an integral part of the curriculum of museum studies programs.

Increase use of evaluation. Museums should increase their use of evaluation strategies to insure the educational effectiveness of their exhibits. All museums should attempt to learn what, if anything, visitors are learning from their exhibits. The assessment of what their audiences learn from their exhibits should be conducted in light of their institution's mission statement, the institution's statement of goals, and ideally the specific objectives written for the exhibit being evaluated.

Successful exhibits. Museums should change their view of successful exhibits. Large crowds are the major indication of a successful exhibit for most museums. Museums should view a successful exhibit as an educationally effective exhibit, not just an exhibit which attracts large crowds. Such a view would be in keeping with museums' assertion that education is their first priority.

Some Final Comments

As mentioned above, a primary purpose of this study is a comparison of current findings to the results of the 1986 survey. It is apparent from a cursory comparison of the two data sets that there has been significant change in a number of areas since 1986. It is also apparent from an instructional development viewpoint that many exhibit development practices have not changed for the better since 1986.

A quote from 1982 provides us with a snapshot of instructional development as an emergent "exhibit development technology" at that time. In the early 80's the curators at the British Museum who were charged with installing the new Hall of Human Biology searched for ways to make their new exhibit more educationally effective; they knew that their previous exhibits had not been as educationally effective as they had wished. They searched until they found techniques and strategies that they felt would make their exhibits more educationally effective. They were pleased with their "discoveries" and published *The Design of Educational Exhibits* (Miles, Alt, Gosling, Lewis, & Tout, 1982) to spread the good word. In describing the systematic process they discovered, Miles et al. (1982) states:

> . . . we have found that a lot of relevant knowledge does in fact exist, and would assist the systematic production of exhibitions of almost any kind. However, it does not for the most part, exist in organized form or in the primary museum literature. Much of it comes from "foreign" fields such as cybernetics, psychology, educational science and information design . . . many exhibition failures are failures of knowledge rather than failures of individuals (Preface).

Miles never appears to have been aware that the field of instructional design incorporates all of the "relevant knowledge" that he describes as coming from "foreign" fields. It will be interesting and informative to compare the results of the 1986 survey with the current survey; perhaps exhibit development practice has improved in the nearly 10 intervening years.

The authors of this paper would like to express their gratitude to Marina Tarshis and Mark Cody who worked as research assistants for this study. Their tireless help with the data analysis did much to help the authors complete this paper.

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EFFECTS OF MEDIA TYPES AND CAMERA POINTS OF VIEW IN SELF-INSTRUCTIONAL MATERIALS ON FIFTH GRADERS' LEARNING OF PSYCHOMOTOR SKILLS

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ABSTRACT

The purpose of this experiment was to study the effects of media types and camera points of view in self-instructional materials on fifth graders' learning of a psychomotor skill, scout knotwork. The researchers assigned 96 fifth graders to six groups not according to any academic standing. Subjects learned scout knotwork via different versions of self-instructional materials and received an immediate performance test. There were two independent variables: media types (videotape, color photo and line-drawing) and camera points of view (subjective and objective POVs).

When one takes a picture or shoots video footage from objective camera point of view, one puts the camera opposite to the demonstrator, with the lens facing the demonstrator. The left-right orientation on the screen or in the picture is opposite to that of the actual execution. While with subjective camera POV, one puts the camera at the eye level or slightly to the side of the demonstrator. Thus, the left-right orientation shown on the screen or in the picture is the same as the actual execution.

Subjects had ten minutes to learn the knotwork from one of the six versions of self-instructional materials; then they were asked to perform the knotwork without any reference. There was a five-minute time limit for the test. Points were given to each product according to its function and accuracy by two independent raters. Whether subjects finished their works within time limit and how long it took them to finish were also recorded. The findings were as follows.

1. There was a significant effect of media types on the accuracy of the knotwork. Line-drawing group performed significantly better than color photo group. However the main effect of camera POVs and the interaction effect of media types and camera POVs on accuracy were not significant.
2. There were no significant effects of media types and camera POVs on the function of the knotwork.
3. There were no significant effects of media types and camera POVs on the speed and the amount of time subjects need to finish the work.

Based upon the experiment findings, the researchers suggested the producers of self-instructional materials could consider to use line-drawing to present knotwork to fifth graders. It was also suggested that future researchers could consider to use the degree of realism in visuals as an independent variable for further investigation.

EFFECTS OF MEDIA TYPES AND CAMERA POINTS OF VIEW IN SELF-INSTRUCTIONAL MATERIALS ON FIFTH GRADERS' LEARNING OF PSYCHOMOTOR SKILLS

CHAPTER 1 INTRODUCTION

BACKGROUND OF THE STUDY

In shopping around toy stores or stationary stores in Taiwan, one finds many children' craft kits, e.g., Legos, Chinese knotwork, paper -folding kits, model car assembly kits, among many others, that are accompanied by instructional materials. These instructional materials take different forms, including videotapes and print materials (verbal explanations plus line-drawings or verbal explanations plus pictures). It is expected that children will be able to follow the instructions in working with the craft kit.

Use of such instructions stimulates research interest in conducting studies to investigate the effect of media types on children's learning of psychomotor skills. According to the proper-use-of-media suggestion, there should be a match between media attributes, instructional content, and learners. Most of the craft work consists of dynamic procedures that can be presented well in videotapes. But if children wish to have an overview of the entire procedure, or if they wish to refer the procedure back and forth, then print materials seem to be more appropriate. A great many instructional materials consist of verbal explanations plus line-drawings due to their low production cost. Exactly which media type best facilitates children's learning of psychomotor skills such as craft work?

From the video production experience, the researchers also wish to compare the instructional effects of different camera points of view (POVs). When one takes a picture or shoots video footage from objective camera point of view, one puts the camera opposite to the demonstrator, with the lens facing the demonstrator. The left-right orientation on the screen or in the picture is opposite to that of the actual execution. While with subjective camera POV, one puts the camera at the eye level or slightly to the side of the demonstrator. Thus, the left-right orientation shown on the screen or in the picture is the same as the actual execution. When children watch video or read print materials to learn a psychomotor skill, such as scout knotwork, in which left-right direction makes a difference, which camera POV will be more effective instructionally?

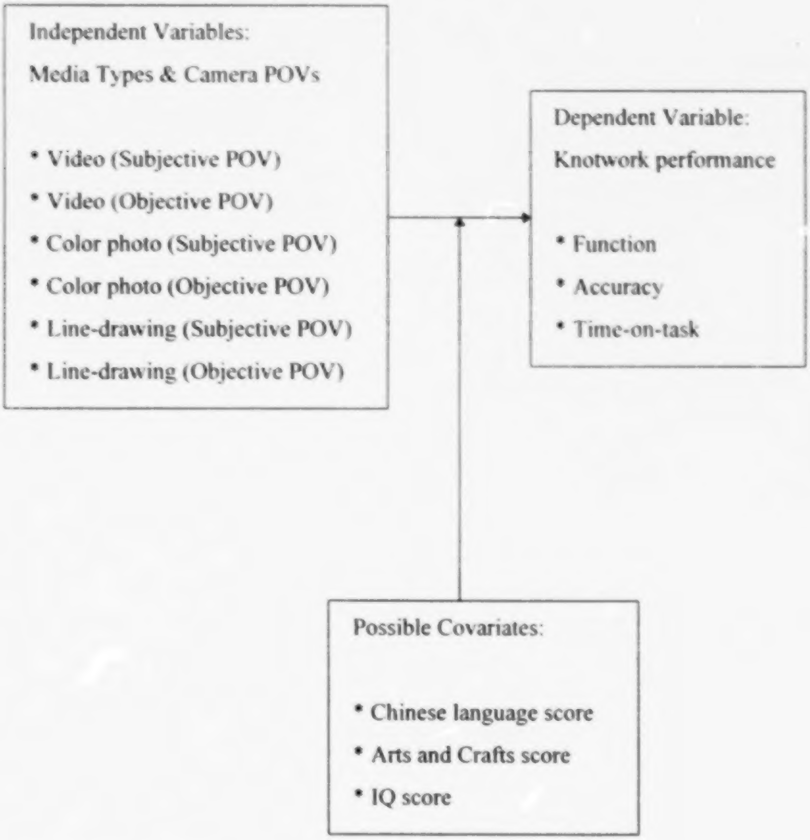
These media types and camera POVs are the variables researchers investigated in this study.

RESEARCH PURPOSE

The purposes of this study are as follows.

1. To investigate the effect of media type on children's learning of psychomotor skills.
2. To investigate the effect of camera POV on children's learning of psychomotor skills.
3. To investigate the interaction effect of media type and camera POV on children's learning of psychomotor skills.

RESEARCH FRAMEWORK


Independent Variables:
Media Types & Camera POVs
* Video (Subjective POV)
* Video (Objective POV)
* Color photo (Subjective POV)
* Color photo (Objective POV)
* Line-drawing (Subjective POV)
* Line-drawing (Objective POV)
Dependent Variable:
Knotwork performance
* Function
* Accuracy
* Time-on-task
Possible Covariates:
* Chinese language score
* Arts and Crafts score
* IQ score

SCOPE OF THIS STUDY

When interpreting results of this study, readers are encouraged to consider the following limitations.

1. Subjects were 96 fifth graders enrolled in an urban public elementary school in northern Taiwan. Their IQ score was considered high (PR=73) among children of this age. Thus, the findings might not apply to self-learners of other ages or other intelligent levels.
2. The psychomotor skill studied was scout knotwork which requires hand-eye coordination, but not other physical skills. Thus, the findings might not apply to those psychomotor skills that require whole-body coordination, e.g., riding a bicycle, ice-skating, etc..

CHAPTER 2 REVIEW OF LITERATURE

Four topics are addressed in this chapter. First, a review of research studies on realism in visuals is presented; second, the characteristics of media, instructional contents and learners are discussed; third, related important literature on psychomotor learning is reviewed briefly; finally, research questions and hypotheses are listed.

REALISM IN VISUALS

It is said that "to see is to believe", so visuals are often used to facilitate learning. This could be exemplified at all levels of instructional materials. Photographs, slides, videotapes, models, actual objects etc. are frequently used as parts of various instructional strategies. Research on visuals can be traced back to the 1940s and 1950s. A wealth of theoretical orientations were identified in this period, such as Morris' iconicity theory (1946), Dale's cone of experience (1946), and Carpenter's sign similarity hypothesis (1953). The generic idea was that the greater number and the more realistic the cues in the learning environment are, the more complete the learning will be. Finn (1953) also suggested that the more realistic or lifelike the stimulus in instruction was, the greater the probability it had for facilitating learning. This idea is similar to Osgood's more detachable-less detachable continuum (1953), Gibson's projective-conventional continuum (1954), and Knowlton's transparency-opacity continuum (1964) in the later. The main thrust of these theories is presented in Figure 2-1.

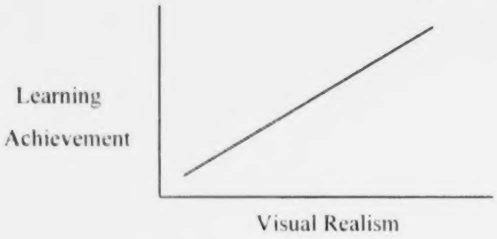


Fig. 2-1: Relationship between learning achievement and visual realism (Realism Theory)

However, Dwyer (1978) had a totally different perspective. He argued that the number of visual cues in the learning process was not a guarantee of better learning results. In other words, there was an optimal limit on the number of visual cues. Before reaching learners' upper limit , the relationship between visual cues and learning outcome was generally similar to Morris, et al. had proposed, but, when the number of visual cues exceeded the learner's perception load, the learning results would then decline. Therefore, too few or too many visual cues are both obstacles to effective learning, and the relationship between learning result and visual realism should be a curvilinear one (see Figure 2-2). Before Dwyer, Miller (1957), Attneave (1959), and Travers et al. (1967) also claimed that irrelevant cues would interfere with the learning process. Their perspective was known as "Relevant Cue Hypothesis".

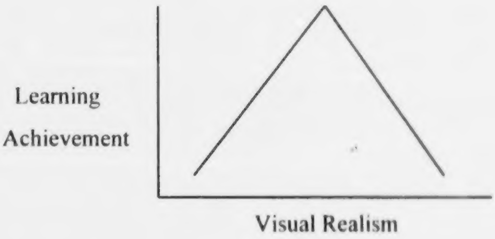


Fig. 2-2: Relationship between learning result and visual realism (Relevant Cue Hypothesis)

In this study, the researchers selected line-drawings, photographs, and videotapes as the three experimental media types. According to Morris (et al.)'s theory, the line-drawing and the videotape groups should have shown, respectively, the lowest and the highest learning efficiency (see Figure 2-3).

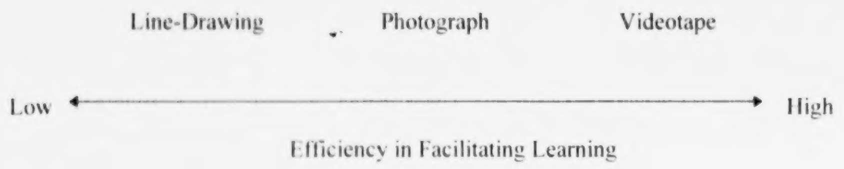


Fig. 2-3: The learning efficiency (based on Morris et al.)

While according to Dwyer (1978), realism in visual illustrations may be described as the number of stimuli capable of conveying information to students, the kind of stimuli that can be presented in different types, amounts, degrees of visual realism will have differing effects on students' learning achievements. If a teacher gives a highly realistic visual stimulus to students, students might fail to get the basic ideas, because students are probably too busy watching every detail and forget or fail to identify the primary information. Dwyer called this situation "the scanning syndrome". After synthesizing Dwyer's studies from the 1960s to the 1970s, the experimenters found it difficult to derive hypotheses for the present study.

The researchers found only few studies on the topic of psychomotor learning. Most of them focused on physical training (Baggett, 1983; Ulrich, 1976), or on disabled learners' skill acquisition (Jeffries & Pring, 1987; Rodriguez, 1986). Some studies mentioned camera angle (Beverly & Young, 1978; Bryski, 1988; Eadie, 1991). However, they investigated the relationship between viewers' perceptions of TV news anchors' credibility and camera angle strategies, which was outside the scope of this study. Hozaki (1987) did a study on the effects of field dependence/independence and visualized instruction in a paper-folding lesson on performance and comprehension. He found that videotape group's learning result was significantly higher than a simple line-drawing group's, and that the simple line-drawing group showed significantly greater learning than the verbal group. However, Chou (1990) found no significant difference between computer graphic presentation format and videotape presentation format when college students were taught to evaluate the correct position for the long jump. That might indicate that the realism of visual information has no specific relationship with the learner's results.

From the above studies, we see no clear indication of which media type best facilitates students' learning of psychomotor skills. The researchers also question whether results from studies using Americans as subjects apply to a Taiwanese environment. How can instructors use visuals for illustrations effectively and efficiently? This is the main concern of the present study.

CHARACTERISTICS OF MEDIA, INSTRUCTIONAL CONTENTS AND LEARNERS

Instructors are always concerned about what media to use, what contents to provide, what kind of students to teach, and what kind of learning effects are desired. Salomon (1983) suggested teachers should base their selections on media-attribute analysis. Following is the attribute comparison of line-drawing, photograph, and videotape.

Media Type	**Still Media**		**Active Media**
	Line-Drawing	Photograph	Videotape
Appropriate Audience	Audience with abstract-thinking ability	Audience with concrete-thinking ability	Audience with TV literacy ability
Appropriate Contents	•still •need to be observed repeatedly •emphasize main character by getting rid of unnecessary back/foreground	•still •need to be observed repeatedly •color	•running/still •need to be observed repeatedly •color •continuing process •extend/shorten time/space
Inappropriate Contents	•continuing process •concrete contents •depth •color •present depth and colors	•continuing process •concrete contents	•contents which need to be reordered frequently •abstract principles or rules •long text in length

Figure 2-4: Comparison of media attributes

INSTRUCTIONAL CONTENTS

There are three educational objective domains: cognition, affection and psychomotor skills. This study concentrates on the psychomotor domain. The researchers adopted the popular psychomotor skill taxonomy (Harrow, 1972), presented briefly below.

Level 1. Reflex movements;

Level 2. Basic-fundamental movements;

Level 3. Perceptual abilities;

Level 4. Physical abilities;

Level 5. Skilled movements; and

Level 6. Non-discursive communication.

Each of the above six can be divided into several sub-levels. For instance, Skilled movement can be divided into three sub-levels: Simple adaptive skill, Compound skill and Complex adaptive skill. Every sub-level has "Beginner", "Intermediate", "Advanced", and "Highly skilled" degrees.

In this study, scout knotwork is the target skill. It requires learners to coordinate their vision, thought and manual dexterity abilities to complete the specified tasks correctly within a limited time. This skill is a beginning familiarity one on the Simple adaptive skill sub-level under the Skilled movements level in Harrow's taxonomy.

LEARNER'S CHARACTERISTICS

The subjects in this study were fifth graders in a Taiwan elementary school. According to Piaget's theory, children of this age are at the Concrete-operation stage. Most of these children are already able to form concrete concepts and know how to distinguish things by their features. Salomon (1983) and Salomon & Leigh (1984) found that children usually feel TV is easier to understand than print media, so, they invest less mental effort while watching TV program. This is an important reason why children have lower learning results after watching TV but have higher learning results after reading contents from print. The researchers also interviewed these children's instructors and parents, who mentioned that children of this age usually don't like to do things that are considered inappropriate to their gender. For example, boys don't like to learn how to sew dolls; while girls don't like to assemble model tanks. Based on these opinions, the authors selected a gender-free skill (i.e., scout knotwork) for this study.

RELATED LITERATURES ON PSYCHOMOTOR SKILL LEARNING

1. Researcher: Chou, C. (1990)

Topic : Effects of visual information presentation mode and testing mode on skill analysis training in an interactive video setting

Subject : 105 students at Ohio State University

Finding : The degree of visual realism in instructional media has no significant effect on learning results

2. Researcher: Hozaki, N. (1987)

Topic : The effects of field dependence/independence and visualized instruction in a lesson of origami, paper folding, upon performance and comprehension

Subject : 115 students at Ohio State University

Finding : 1. Videotape group's learning results are significantly better than simple line-drawing group.

2. Simple line-drawing group's learning results is significantly better than print group.

3. Researcher: Baggett, P. (1983)

Topic : Learning a procedure from multimedia instructions: The effects of film and practice.

Subject : 360 students at Colorado University

Finding : 1. Practice group had the highest scores in an immediate posttest.

2. Practice-then-watch-video group had the highest scores in a delayed posttest.

4. Researcher: Arnold, T. C. & Dwyer, F. M. (1975)

Topic : The relationship between various visual effects in different instructional materials and different instructional objectives.

Subject : 185 11th-grade students in USA

Finding : Subjects learning from visual instructional materials scored significantly higher than counterparts with no visuals.

5. Researcher: Dwyer, F. M. (1967, 1968, 1969a, 1969b, 1970, 1971a, 1971b, 1971c, 1971d, 1971e, 1972, 1973a, 1973b, 1973c, 1975, 1976, 1977)

Nature of Topics : Serial research on the relationship between visual realism and learning results

Finding : 1. The realism continuum for visual illustrations is not an effective predictor of learning efficiency for all types of educational objectives.

2. The use of certain types of visual illustrations to facilitate specific types of educational objectives significantly improves student achievement.

3. All types of visual illustrations are not equally effective in facilitating student achievement of different educational objectives.

4. The use of visual illustrations designed specifically to complement printed instruction does not automatically improve student achievement.

5. For the teaching of specific types of educational objectives, printed instruction without visualization is as effective as visualized instruction for certain types of students.

RESEARCH QUESTIONS AND RESEARCH HYPOTHESES

The authors of this study wished to answer the following research questions.

Research Question #1:

What effect do media type and camera POV have on the function of subjects' knotwork?

Research Hypothesis #1:

Media type and camera POV would significantly affect the function of subjects' knotwork.

Research Question #2:

What effect do media type and camera POV have on the accuracy of subjects' knotwork?

Research Hypothesis #2:

Media type and camera POV would significantly affect the accuracy of subjects' knotwork.

Research Question #3:

What effect do media type and camera POV have on subjects' time-on-task?

Research Hypothesis #3:

Media type and camera POV would significantly affect subjects' time-on-task.

CHAPTER 3 METHODOLOGY

SUBJECTS

Subjects were 96 fifth graders enrolled in an urban public elementary school in northern Taiwan during the spring of 1994. Among them, 48 were boys and 48 were girls. None of them were boy scouts or girl scouts, and none had learned scout knotwork or Chinese knotwork. Descriptive statistics of subjects' important characteristics were reported in Table 3-1.

Table 3-1

Group Means and Standard Deviations of Last Semester's Chinese Language, Arts and Crafts, Raven Coloured Progressive Matrices (CPM) Score

		Chinese Language Score		Arts & Crafts Score		CPM IQ Score	
Group	n	M	SD	M	SD	M	SD
Video (Subjective POV)	16	86.94	4.97	92.31	1.89	40.12	8.66
Video (Objective POV)	16	88.31	4.59	93.19	1.80	42.19	9.96
Color photo (Subjective POV)	16	89.50	3.54	93.25	2.18	37.75	8.54
Color photo (Objective POV)	16	90.56	3.86	93.50	3.03	42.94	4.37
Line-drawing (Subjective POV)	16	90.69	3.81	94.31	1.92	43.69	5.95
Line-drawing (Objective POV)	16	88.44	3.18	93.31	1.78	43.00	7.42
Total	96	89.07	4.15	93.31	2.17	41.61	7.79

Analysis of Variance (ANOVA) indicated that there was no significant difference among these six groups' mean Chinese Language scores, Arts & Crafts scores and CPM IQ scores; F(5, 95)=2.0702, p=.0764; F(5, 95)=1.4302, p=.2211; F(5, 95)=1.0319, p=.4038. The researchers thus assumed that these groups were equal in terms of their entry behaviors for this knotwork lesson.

INSTRUMENTS

A. Research instruments

Based upon the two independent variables in this experiment, media type and camera POV, the researchers developed the following six versions of self-instructional materials on scout knotwork. The task consisted of two kinds of knots, which combined could be used to hang up a bucket or a bowel.

1. Subjective POV video
2. Objective POV video

These videotapes were four minutes and forty seconds long. There were Mandarin Chinese narration as well as Chinese-language subtitles. The demonstrator was a female supervisor of the scout club in the experiment elementary school. The demonstrator's narration was recorded on the shooting spot.

3. Subjective POV color photos
4. Objective POV color photos

There were eleven color photos which were accompanied by their verbal explanation perspectively. The photos emphasized the rope, the bucket, and the demonstrator's hands, though other things (e.g., foreground, background, the demonstrator) still could been seen partly.

5. Subjective POV line-drawings
6. Objective POV line-drawings

There were eleven line-drawings which were accompanied by their verbal explanation perspectively. Only the rope and the bucket were presented in the line-drawings; the demonstrator, the foreground and the background were omitted.

The verbal explanation in these six group was identical in terms of its contents. However, it differed in terms of the presenting format. In the two video versions, the verbal explanation was presented in the formats of narration and subtitle. In the photos and line-drawings versions, the verbal explanation was presented in print.

B. Evaluation Instrument

The researchers adopted the product evaluation method to assess subjects' learning achievement. They developed a checklist with the consultation from children scout supervisor in the elementary school. According to the checklist, the maximum point was six, one point for the function of the knotwork (i.e., could be used to hang up a bucket or a bowel successfully), the other five points for the accuracy of the knotwork.

To avoid experimenter bias, the researchers had two independent raters who were blind to the purpose of this experiment evaluated subjects' knotwork, the Pearson Product Moment Correlation coefficients were 1.000 (for the function score) and .9931 (for the accuracy score) respectively ($p < .01$).

PROCEDURES

The study adopted factorial experiment design. There were two independent variables. One was media type, which included videotape, color photo and line-drawing; the other was camera POV, which included subjective and objective camera POVs.

CAMERA POINTS OF VIEW

MEDIA TYPES	SUBJECTIVE	OBJECTIVE
VIDEO	Group 1	Group 2
COLOR PHOTO	Group 3	Group 4
LINE-DRAWING	Group 5	Group 6

Figure 3-1: Experiment design

Ninety six subjects were assigned to these six groups not according to any academic standing. There were sixteen subjects in each group. Pretest was not administered since the researchers assumed these subjects were equal in terms of their entry behaviors for the following reasons.

1. None of these subjects were boy scouts or girl scouts.
2. None of these subjects had learned scout knotwork or Chinese knotwork.
3. The preliminary Statistical analyses indicated these subjects were equal on their Chinese-language scores, Arts and Crafts scores, and CPM IQ scores.

The experiment was conducted using lunch recess hours during March, 1994. The procedure included an opening announcement which informed subjects about the experimental procedure, a self-learning period (ten minutes) and an immediate posttest (five minutes). The total length of the experiment was about thirty minutes. During the self-learning period, subjects were given the self-instructional materials, a rope, and a bucket. They could decide how they wanted to use them to facilitate their learning. Some children read the photo/line-drawing brochure or watched the video first, then tried to perform the knotwork. But the majority of the subjects tried to perform the knotwork while going through self-instructional materials.

To avoid experimenter bias, the researchers had a teacher from the elementary school act as the experimenter, and two independent raters evaluate subjects' products. All of them were blind to the purpose of this experiment. The acting experimenter knew some of the subjects, while the raters didn't know any of the subjects. The authors of this study, who didn't know any of the subjects, were present all the time to ensure the experiment was conducted according to the procedure.

STATISTICAL ANALYSIS

Arithmetic mean, standard deviation, Pearson product-moment correlation, two-way analysis of variance, Tukey's HSD post hoc, as well as the test of homogeneity of proportions in chi-square test were performed on the data collected from the experiment.

CHAPTER 4 RESULTS

Research Question #1:

What effect do media type and camera POV have on the function of subjects' knotwork?

Finding #1:

The test of homogeneity of proportions in chi-square test was performed on the function score of subjects' knotwork. It was found that there was no significant difference among media types (chi-square value= 1.0114, $p>.05$) and camera POVs (chi-square value = .1364, $p>.05$) on percentages of the knot-work which could be used to hang up a bucket successfully.

Discussion:

The experimenters felt that these non-significant differences might due to the loose grading policy, i.e., as long as the knot could be used to hang up a bucket or a bowel, the graders considered the knot be a functional one and granted the function score.

Research Question #2:

What effect do media type and camera POV have on the accuracy of subjects' knotwork?

Finding #2:

Analysis of Variance was performed on the accuracy score of the knotwork. It was found that media type had a significant effect on the accuracy of the knotwork (F=4.835, p=.010). Tukey's HSD post hoc indicated that line-drawing group performed significantly better than the color photo group (p=.010). However the main effect of camera POV and the interaction effect of media type and camera POV on accuracy was not significant (F=.150, p=.699; F=1.566, p=.215). See tables 4-1, 4-2 and 4-3.

Table 4-1:

Summary Table of Analysis of Variance on Accuracy Scores

Sources of Variation	d.f.	SS	MS	F	p
Media type	2	11.314	5.657	4.835	.010**
Camera POV	1	.176	.176	.150	.699
Interaction	2	3.665	1.832	1.566	.215
Error	85	99.457	1.170		
Total	90	114.681	1.274		

Table 4-2:

Descriptive Statistics of Different Media Type on Accuracy Scores

Media Type	n	M	SD	Min.	Max.
1. Videotape	32	2.78	1.34	0	5
2. Color Photo	32	2.28	1.08	0	5
3. Line-drawing	32	2.84	1.22	0	5

Table 4-3:

Descriptive Statistics of Different Camera POV on Accuracy Scores

Camera POV	n	M	SD	Min.	Max.
1. Subjective POV	48	2.48	1.41	0	5
2. Objective POV	48	2.79	1.01	0	5

Discussion:

This finding (line-drawing group performed significantly better than color photo group) didn't support the realism theories (Morris, 1946; Dale, 1946; Carpenter, 1953; Finn, 1953; Osgood, 1953; Gibson, 1954; Knowlton, 1964); nor did it correspond with the finding reported by Hozaki (1987). In his dissertation, Hozaki investigated the effects of different type of visual instruction on paper-folding performance. He reported that the videotape group performed significantly better than the line-drawing group; and that the line-drawing group performed significantly better than the verbal group. All differences reached .001 significance level. However, the researcher believed the grading procedures were arguable, since Hozaki himself was one of the two graders, experimenter bias might have been presented; and he did not report the inter-rater reliability.

This finding (line-drawing group performed significantly better than color photo group) supported Attneave (1959), Dwyer (1976), Miller (1957) and Travers et. al. (1967). They all suggested that learning achievement declined when irrelevant cues and important instructional cues were presented since it created disturbance. Flemming (1970) also suggested instructional designers present only those absolutely necessary instructional cues to avoid wasting perceptual capacity. In this study, only the scout rope and the bucket were presented in the line-drawing version of the self-instructional materials; the demonstrator, the foreground and the background were all omitted. While subjects in the photo group might be attracted by the irrelevant cues, such as the body, the clothes of the demonstrator, and the background. Also, Travers et al. (1964) proposed an interesting viewpoint, i.e., visual information was stored in a form that resembled the format of line-drawing in the memory. Thus material presented in a line-drawing format is easier for human beings to organize, process and memorize. Our findings also support this viewpoint.

Our other finding, that camera POV had non significant effect, could be explained by the experimental observation that almost all the subjects who were assigned objective POV materials tried to simulate the subjective POV by turning their bodies slightly to more easily follow instructions with left-right orientations (e.g., "Put the rope in your left hand on the top of the rope in your right hand".).

Research Question #3:

What effect do media type and camera POV have on subjects' time-on-task?

Finding #3:

Subjects were classified into two categories, those who finished the knotwork within five-minute time limit and those who didn't. The test of homogeneity of proportions in the chi-square test was performed to analyze the data. It was found that there was no significant difference among media types (chi-square value= 1.0292, $p > .05$) and camera POVs (chi-square value = .8440, $p > .05$) on percentages of subjects finished within the time limit.

The researcher then performed ANOVA on time (in seconds) subjects used to finish their tasks.

Those who didn't finish within the time limit were eliminated from this analysis. Analysis results indicate that there were no significant differences among media type (F=2.386, p=.098), camera POV (F=1.630, p=.205) and interaction (F=.142, p=.868). See tables 4-4, 4-5 and 4-6.

Table 4-4:

Summary Table of Analysis of Variance in time-on-task (in seconds)

Sources of Variation	d.f.	SS	MS	F	p
Media type	2	23671.263	11835.831	2.386	.098
Camera POV	1	8086.560	8086.560	1.630	.205
Interaction	2	1411.230	705.615	.142	.868
Error	85	421721.189	4961.426		
Total	90	455325.033			

Table 4-5:

Descriptive Statistics on Different Media Type in Time-on-task (in seconds)

Media Type	n	M	SD	Min.	Max.
1. Video Tape	30	131.90	77.12	40	300
2. Color Photo	32	152.97	76.16	37	300
3. Line-drawing	29	113.24	53.10	39	300

Table 4-6.

Descriptive Statistics on Different Camera POVs on Time-on-task (in seconds)

Camera POV	n	M	SD	Min.	Max.
1. Subjective POV	44	143.36	67.78	39	300
2. Objective POV	47	124.00	73.61	37	300

Discussion:

Five of the 96 subjects failed to finish the knotwork within the five-minute time limit. Two of these five subjects belonged to the videotape group and the other three belonged to the line-drawing group. Four of these five subjects belonged to the subjective POV group, while the other one belonged to the objective POV group. They were all excluded from the ANOVA analysis. Had the researcher requested subjects to finish the knotwork regardless of the time limit, it would have enlarged the mean difference between subjective and objective POV groups, and would probably have resulted in significant differences in time. However, this inclusion would have reduced the mean difference among video, photo and line-drawing groups.

CHAPTER 5 SUMMARY AND RECOMMENDATION

SUMMARY

In order to investigate the effects of media type and camera POV in self-instructional materials on children's learning of scout knotwork, the researchers assigned 96 fifth graders to six groups according to no academic standing. Subjects learned scout knotwork via different versions of self-instructional materials and received an immediate performance test. The six groups used:

1. subjective POV video,
2. objective POV video,
3. subjective POV color photos,
4. objective POV color photos,
5. subjective POV line-drawings, and
6. Objective POV line-drawings.

Subjects had ten minutes to learn the knotwork from one of the six versions of self-instructional materials; they were then asked to perform the knotwork without any reference to self-instructional materials. There was a five-minute time limit for the test. Points were given for each product according to its function and accuracy by two independent raters. Whether subjects finished their tasks within the time limit, and how long it took them to finish, were also recorded. The findings are as follows.

1. There was a significant effect of media types on the accuracy of the knotwork. The line-drawing group performed significantly better than the color photo group. However the effect of camera POV and the interaction effect of media type and camera POV on accuracy were not significant.
2. Media type and camera POV had no significant effects on the function of the knotwork.
3. Media types and camera POV had no significant effects on the speed and the amount of time subjects need to finish the work.

RECOMMENDATION

Based upon these experimental findings, the researchers suggest that producers of self-instructional materials consider using line-drawing to present knotwork to fifth graders. It is also suggested that future researchers consider using the degree of realism in visuals as an independent variable for further investigation.

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